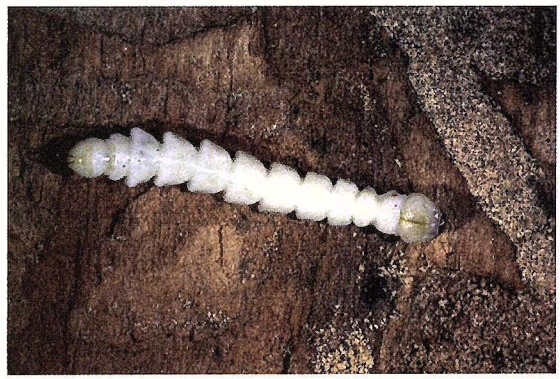
Ornamental Plants
Annual Reports and Research Reviews
2003



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January 2004
Special Circular 193
Ohio Agricultural Research and Development Center
In Partnership With Ohio State University Extension

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The Ohio State University
Ohio Agricultural Research and Development Center
1680 Madison Avenue
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In Partnership With
Ohio State University Extension
College of Food, Agricultural, and Environmental Sciences

Ornamental Plants
Annual Reports and Research Reviews
2003

Edited By

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Ohio State University Extension
Department of Horticulture and Crop Science
The Ohio State University

January 2004
Special Circular 193
Ohio Agricultural Research and Development Center
In Partnership With Ohio State University Extension

Cover Photo:

Emerald ash borer adult and larvae. The emerald ash borer has the potential to decimate ash throughout their range in North America, and efforts to eradicate this invasive pest are underway. For additional information about this serious threat, see the article in this publication titled *Emerald Ash Borer: The Beginning of the End of Ash in North America?*

Salaries and research support were provided by state and federal funds appropriated to the Ohio Agricultural Research and Development Center and Ohio State University Extension of The Ohio State University's College of Food, Agricultural, and Environmental Sciences. Additional grant support was provided by the organizations and companies listed in the individual research and Extension reports.

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Ohio State University Extension Nursery, Landscape, and Turf Team Directory: 2004

Our Vision

The vision of the Extension Nursery, Landscape, and Turf Team is to serve as the University's partner with the green industry to position us for the future.

Our Mission

The mission of the Extension Nursery, Landscape, and Turf Team, through our interdisciplinary and industry partnerships, is to improve the process of acquisition, delivery, and support of accurate, practical, and timely educational resources.

An Invitation

Membership on the team is based on interest and commitment to the vision and the mission of the team. Potential members are encouraged to participate in some of our activities to determine if they would like to become a part of our team. If you are interested in the work of the team, please contact any of the team members.

The ENLT Team greatly appreciates the significant funding support of the Ohio Nursery and Landscape Association.

Team Members

Betsy Anderson

- Ornamental plant pesticide research (IR-4 Program)
- Biological pest control
- Identification of nursery, greenhouse, and landscape pesticide needs
- Registration of new pesticide products

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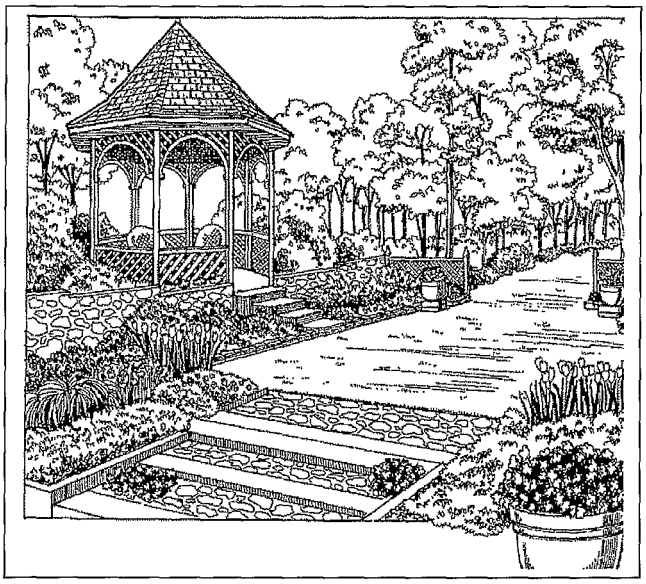

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— ❁ —

During the growing season, the team teleconferences weekly and develops a newsletter called the *Buckeye Yard and Garden Line,* which is available by a fax subscription service (contact a local team member) or on the World-Wide Web at:

http://www.hcs.ohio-state.edu/hcs/hcs.html

(Ohio State University Department of Horticulture and Crop Science, *Horticulture and Crop Science in Virtual Perspective)*

Buckeye Yard and Garden Line
Fax Centers

Clark County	Pam Bennett
Clermont County	Gary Gao
Cuyahoga County	Tim Malinich
Franklin County	Jane Martin
Hamilton County	Joe Boggs
Lake County	Randy Zondag
Lucas County	Amy Stone
Montgomery County	Pete Lane
Putnam County	Glen Arnold

~ 2 ~
Floriculture Industry Roundtable of Ohio: 2004

Financially supported by the Ohio Floriculture Foundation.

Our Mission

The mission of the Floriculture Roundtable of Ohio is to provide an educational forum to floriculture Extension personnel, growers, and members of the allied industries across the Midwestern region, currently including Ohio, Michigan, Pennsylvania, Kentucky, and Indiana, for the exchange, discussion, and dissemination of information related to floriculture.

Serving You

Do you ever have problems with crops? The Roundtable offers you free assistance in finding solutions. All persons listed in this directory are just a phone call away. Take advantage of the opportunity!

Directory developed by Charles Behnke, Ohio State University Extension, Lorain County, and Claudio Pasian, The Ohio State University, Department of Horticulture and Crop Science.

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Kneen, Hal
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McMahon, Robert W. (Bob)
Metzger, Jim
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Ellsworth, Denise
Nameth, Steve
Taylor, Nancy

Entomology/IPM

Cañas, Luis
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Kneen, Hal
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Composting

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Crop Physiology

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Nutrient Analysis/Water Quality

Carver, Steve
Krauskopf, Dean
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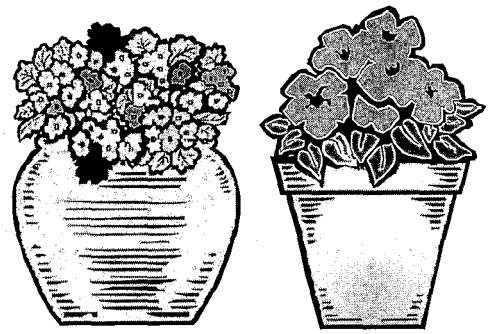

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330-497-2807 Fax
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- Integrated pest management
- Plant diseases

Everett, Craig

OSU Extension Program Assistant,
Horticulture, Wood County
440 E. Poe Road, Suite A
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419-354-9050
419-352-7413 Fax
everett.33@osu.edu

- Greenhouse management and production

Gao, Gary

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P. O. Box 670, 1000 Locust Street
Owensville, OH 45160
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513-732-7060 Fax
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- Greenhouse management

Jones, Michelle L.

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- Production/post-production physiology
- Biotechnology
- Germplasm enhancement
- Ethylene

Kneen, Hal

OSU Extension Agent, Horticulture,
Meigs County
Mulberry Heights
P. O. Box 32
Pomeroy, OH 45769
740-992-6696
740-992-7931 Fax
kneen.1@osu.edu

- Greenhouse management
- Small business management
- Production economics
- Marketing

Krauskopf, Dean

Greenhouse Agent, Southeast Michigan
Michigan State University
MSU Extension
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313-833-3298 Fax
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- Greenhouse crop nutrition
- Foliar and media analysis
- Greenhouse crop management

Ling, Peter

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Development Center

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Wooster, OH 44691-4096
330-263-3857
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- Greenhouse plant growth control systems
- Digital image applications

McMahon, Margaret (Peg)

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614-292-8867
614-292-3505 Fax
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- Floriculture crop physiology
- Light quality regulation of crop development
- Greenhouse management
- Production of floriculture crops

McMahon, Robert W. (Bob)

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The Ohio State University
Agricultural Technical Institute
1328 Dover Road
Wooster, OH 44691-4000
800-647-8283 Ext. 1320 (Ohio only)
330-264-3911 Ext. 1320
330-262-7634 Fax

- IPM
- Control of insect pests of floriculture crops with natural enemies and use of hot-water drenches and sprays, and manipulation of plant height by environmental manipulation (water and temperature)
- Greenhouse production and management

Metzger, James (Jim)

Professor
Department of Horticulture and Crop Science
The Ohio State University
2021 Coffey Court
Columbus, OH 43210
614-292-3854
614-292-7162 Fax
metzger.72@osu.edu

- Role of hormones in plant growth and development
- Environmental control of flowering
- Use of biotechnology to improve floricultural crops

Nameth, Steve

Associate Professor and Chair and Extension Specialist, Floral and Nursery Crops
Department of Plant Pathology
The Ohio State University
2021 Coffey Road
Columbus, OH 43210
614-292-8038
614-292-7162 Fax
nameth.2@osu.edu

- Diseases of floral crops: identification, control, and management
- Identification and characterization of viruses of floral crops

Pasian, Claudio

Associate Professor and Extension Specialist, Floriculture
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The Ohio State University
2001 Fyffe Court
Columbus, OH 43210

614-292-9941
614-292-3505 Fax
pasian.1@osu.edu

- Production and management
- Modeling and timing of floricultural crops
- Water quality and nutrition of floricultural crops

Rhodus, Tim

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- Management and economics of horticultural crops
- Multimedia applications for marketing and education

Short, Ted

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The Ohio State University
Ohio Agricultural Research and Development Center
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Wooster, OH 44691
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330-263-3670 Fax
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- Greenhouse system design for optimum production
- Evapotranspiration of greenhouse crops
- Solar energy systems
- Mechanization of horticultural crops
- Natural ventilation of greenhouses

Taylor, Nancy

Director, C. Wayne Ellett Plant and Pest Diagnostic Clinic
The Ohio State University
110 Kottman Hall
2021 Coffey Road
Columbus, OH 43210
614-688-5563
614-292-4455 Fax
taylor.8@osu.edu

- Diagnosis of diseases of floral and other greenhouse crops

Watson, Maurice

Associate Professor and Extension Soil Specialist
School of Natural Resources
The Ohio State University
Ohio Agricultural Research and Development Center
1680 Madison Avenue
Wooster, OH 44691
330-263-3755
330-263-3658 Fax
watson.8@osu.edu

- Analysis of soil, soilless mix, sewage sludges, manures, and water
- Water quality, composting, and environmental pollution problems

Floriculture Industry Roundtable of Ohio (FIROO) Activities Include:

- Assisting growers with crop production problems.
- Holding biweekly conference calls to assess the state of the industry. These calls are used as an educational forum by Roundtable members. Grower participation in the biweekly phone calls is possible (and encouraged) on a port-available basis by contacting Charles Behnke at 440-326-5859 prior to the biweekly conference.
- Preparing and faxing out informational alerts (FIROOFAX) to industry members when emergencies arise.
- Collaborating with the Ohio Florists Association and other regional grower associations in the organization of educational seminars and workshops.

Do not hesitate to get in touch with any of the Roundtable members listed in this Directory if you have any floricultural problem or wish to share information.

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Ohio State University Extension 2003 Buckeye Yard and Garden Line Evaluation Survey

Amy K. Stone and James A. Chatfield

Summary

One hundred fifty-two respondents completed and returned the 2003 *Buckeye Yard & Garden Line (BYGL)* Survey. From their subscriptions, information from *BYGL* is then further disseminated to more than 800,000 additional persons through radio programs, newspaper columns and articles, Master Gardener volunteers, students, and other green-industry employees.

Some 91% of the survey respondents agreed that *BYGL* was useful to their job and business. Of the individuals who responded to the survey, *BYGL* has had an estimated economic impact of $267,000. This is a significant under-representation of the economic impact, since no attempt was made to translate the reported impact to the overall *BYGL* audience.

Introduction

The *Buckeye Yard & Garden Line (BYGL)* is one of the key ways through which Ohio State University Extension and the Extension Nursery Landscape and Turf (ENLT) Team provide ornamental plant and plant problem information to the green industry, Extension offices, and the general public. This article answers some questions about *BYGL* and provides the results of the 2003 *BYGL* Evaluation Survey.

What Is *BYGL?*

The *Buckeye Yard & Garden Line (BYGL)* is a weekly update in the form of a horticultural related newsletter. It is written by OSU Extension agents and specialists, from a conference call held every Tuesday from April – September, with special editions throughout the late fall and winter as needed. *BYGL* is funded by the Ohio Nursery and Landscape Association (ONLA) and OSU Extension, with additional contributions from the Ohio Chapter of the International Society of Arboriculture (Ohio-ISA).

Who Is *BYGL's* Audience?

BYGL is written for green-industry professionals, Extension agents, Master Gardener volunteers, and other horticulturists in Ohio and throughout the United States, especially the Midwest.

Some of those receiving *BYGL* are members of the following: ONLA; ISA; Ohio Turfgrass Foundation (OTF); Ohio Florists Association (OFA); Ohio Fruit Growers; Ohio Vegetable and Potato Growers Association; Ohio Christmas Tree

Amy K. Stone, Ohio State University Extension, Lucas County; and James A. Chatfield, Ohio State University Extension, North District/Department of Horticulture and Crop Science.

Association; Ohio Lawn Care Association (OLCA); Ohio Association of Garden Clubs; Ohio Sod Producers Association; American Association of Botanical Gardens and Arboreta (AABGA); American Horticultural Society (AHS); Associated Landscape Contractors of America (ALCA); American Community Gardening Association (ACGA); Perennial Plant Association (PPA); and Professional Grounds Management Society (PGMS).

How Do You Receive *BYGL?*

There are three ways to receive *BYGL* — by e-mail, by fax subscription, and by going directly on the World Wide Web. Here's how:

- By e-mail: Simply send your e-mail address to Jim Chatfield:

  chatfield.1@osu.edu

- On the World Wide Web: Access *Buckeye Yard and Garden onLine* on Ohio State University's Horticulture and Crop Science in Virtual Perspective

  http://bygl.osu.edu/

- For fax newsletter subscriptions: Contact one of these Ohio State University Extension offices:

  Clark County
  Pam Bennett
  937-328-4607

  Clermont County
  Gary Gao
  513-732-7070

  Cuyahoga County
  Tim Malinich
  216-397-6000

  Franklin County
  Jane Martin
  614-247-6046

  Hamilton County
  Joe Boggs
  513-946-8993

  Lake County
  Randy Zondag
  440-350-2269

  Lucas County
  Amy Stone
  419-578-6783

  Montgomery County
  Pete Lane
  937-224-9654

  Putnam County
  Glen Arnold
  419-523-6294

Is There a Cost for *BYGL?*

Fax subscriptions have a $40 fee to cover phone line costs.

If you are a member of the Ohio Nursery and Landscape Association (ONLA), the Ohio Chapter of the International Society of Arboriculture (Ohio-ISA), or the Ohio Turfgrass Foundation (OTF), this fee is waived as part of your membership benefits.

Where Can You Find the Time for *BYGL?*

Reading time during the growing season comes at a premium, and that is why *BYGL* is formatted in short bytes — one to two paragraphs — of the most relevant information on a particular topic.

We also strive for a lively, user-friendly, and humorous style.

What Is *Buckeye Yard and Garden onLine?*

This is the World Wide Web version of *BYGL*, and it comes not only with the text of *BYGL* available but also with hot links to color images of pests and plants referenced in *BYGL* and to more than 260,000 pages of information from Ohio State University and other land-grant universities.

What is *BYGLive!?*

BYGLive! is a series of informal programs held at arboreta in Ohio. The participants have a chance to see plants and plant and pest development throughout the season, to do some diagnostic troubleshooting, and to provide observations and insights that will add to *BYGL*.

Sites and key contacts for these programs are:

- Cincinnati at Spring Grove Arboretum
  Joe Boggs
  513-946-8993
- Kirtland at Holden Arboretum
  Erik Draper
  440-834-4656
- Toledo at Stranahan Arboretum or Toledo Botanical Garden
  Amy Stone
  419-578-6783
- Wooster at Secrest Arboretum
  Ken Cochran
  330-263-3761

Survey Results

Total Number of Returns: 152

I. General Background Questions

A. What is your primary type of business, operation, or profession?

Number of Commercial or For-Profit Companies: 82
(e.g.: nursery; greenhouse; golf course; lawn-care service; contract landscape maintenance; tree care/arborist; garden center; industrial or office park/plant; landscape architect/designer; or supplier/dealer)

Number of Non-Profit Companies: 37
(e.g.: Extension; park, school, college, or university; museum; cemetery/memorial garden; or government facility)

Number of Non-Professional: 46
(e.g.: home gardener or Extension Master Gardener)

B. Are you a member of the following (please select all that apply):

Ohio Nursery and Landscape Association: 58
International Society of Arboriculture: 24
Ohio Turfgrass Foundation: 11

C. How do you receive BYGL?

E-mail – 118
Fax – 29

D. Do you share your BYGL with others?

Yes – 131
No – 21

II. BYGL Impact and Usefulness

A. How strongly do you agree with each of the following statements? Please write down the most appropriate response.

SA = Strongly Agree
A = Agree
N = Neutral
D = Disagree

SD = Strongly Disagree
NA = Not Applicable

1. *BYGL* was useful to my job and business:
   SA = 92
   A = 45
   N = 03
   D = 00
   SD = 00
   NA = 10

2. *BYGL* helped in answering client/customer questions:
   SA = 86
   A = 45
   N = 05
   D = 00
   SD = 00
   NA = 10

3. I (we) changed some horticultural practices based on information in *BYGL*.
   SA = 46
   A = 57
   N = 30
   D = 02
   SD = 00
   NA = 11

4. I (we) changed some pest management practices based on information in *BYGL*.
   SA = 44
   A = 55
   N = 30
   D = 03
   SD = 00
   NA = 15

5. *BYGL* has resulted in improved customer service in our company or business.
   SA = 50
   A = 52
   N = 09
   D = 00
   SD = 00
   NA = 21

B. What have you learned from *BYGL* this season? Please fill in the blank following each statement.

1.	No. of new insects learned	743
2.	No. of new diseases learned	316
3.	No. of new cultural (non-insect, non-disease) problems learned	299
4.	No. of times pesticide use was improved	1,267

C. Has the information in *BYGL* saved your company money or increased your net profit?
   Yes = 68
   No = 40

1. If you answered *Yes* to question C, please check all that apply. This information will only be used for reporting the economic impacts of *BYGL*.

Time savings to you and your operation	= 50
Reduction of pesticide usage	= 34
Proper selection of plant material	= 28
Proper selection of pesticides	= 47
Improved customer service	= 50

Selected Comments

My favorite weekly contact with the "big guns" of the industry. As always, I appreciate the humor and wonderful quotes.

—Louise Radanovich
Trees by Louise

Very informative – opens our eyes to things [that] otherwise would have gone unnoticed. As always, look forward to the next issue.

—Gregg Ellis
City of Pickerington

An excellent resource for those of us working with the public. Your informal style makes your online magazine easy to read, yet is full of scientific research-based information which serves the needs of the serious scholar and the frantic horticulture tech searching for reasonable answers to unreasonable questions.

—Carol Wilder
University of Kentucky Extension
Jefferson County

I share BYGL with my clients and students, and it is an extremely valuable resource for me when I am guest "expert" on GreenScene, WOSU.

—Deb Knapke
The Garden Sage

BYGL is one of the most informative, entertaining, and educational material[s] I've ever read!

—Paul Mendezoff
Petitii Garden Centers

BYGL has been a great source of information. Keep up the good work!

—Jerry Wolfe
North Canton City Schools

The newsletter is a reliable source of information that is useful in dealing with local insect and disease problems. On several occasions, BYGL information has identified problems that we encounter later in the growing season in NW Ohio.

—Jim Lopshire and Vicky Steele
OSU Extension, Paulding County

BYGL is very helpful is diagnosing problems that our clients bring into the office, especially reminding us of what problems we may be seeing. We are located in Genesee County, Michigan, and use BYGL when we are volunteering as Diagnostic Lab Technicians at MSU Extension two days a week from May to October.

—Ruth Simon
MSU Extension Master Gardener
Genesee County, Michigan

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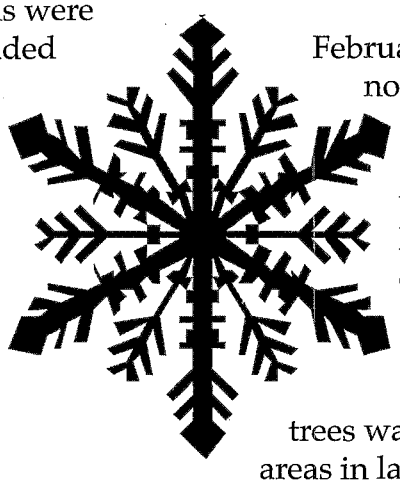
Weather and Environmental Problems of Ornamental Plants in Ohio: 2003

Pamela J. Bennett

Introduction

This report includes a compilation of Ohio weather conditions and noteworthy environmentally induced plant problems in 2003. Observations were drawn from information provided in Ohio State University Extension's *Buckeye Yard & Garden Line,* the Ohio Department of Natural Resources *Monthly Water Inventory Report,* and the State Climatologist's Office for Ohio.



Weather Background

This section discusses precipitation and temperature reports for the season. Table 1 shows statewide precipitation from January through September. Table 2 shows average temperatures and departures from normal for three locations in the state, April through September.

Precipitation

Precipitation for January was below normal for nearly the entire state, except for southeastern Ohio. This resulted in the 20th driest January in the last 109 years of record-keeping. A few weather stations reported significant snow amounts. For example, Chardon reported a record amount of 67" of snow in January, nearly three times the normal snowfall for the month.

February precipitation was above normal across most of the state. Rain, freezing rain, and snow made up the mix with a significant storm on February 14 through 17. The extreme southern portion of Ohio had an ice storm that caused severe damage to trees in the area. Cleaning up trees was still in process in forested areas in late 2003.

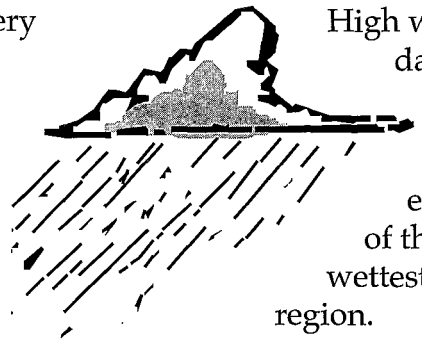
March precipitation was below normal statewide. By the end of these three months, precipitation was below normal statewide.

April precipitation was below normal statewide except for a few areas in south-central Ohio, along the Ohio River, where it was above normal. Central Ohio received a line of severe storms on April 20 with heavy rains, strong winds, and damaging hail.

Things changed in May, as precipitation was notably above normal statewide. For the state, this was the third wettest May during the past 121 years. Regional averages were variable. Showers and

Pamela J. Bennett, Ohio State University Extension, Clark County.

thunderstorms occurred every week of the month.



June precipitation was again generally above normal across most of the state. The greatest amounts of rainfall were in the southeastern part of the state, decreasing to the northwest. It was the 13th wettest June in the past 109 years for the south-central region.

Precipitation for the calendar year was near or above normal by the end of the first six months for the state.

July precipitation was also noticeably above normal across most of the state. However, it was near or below normal in the central and southeastern areas. For the state, this was the fourth wettest July in the past 121 years.

Heavy rains fell the week of July 4 through 11. The greatest amount of rain fell in northwestern and west-central Ohio and some areas of northeastern Ohio; some areas received in excess of 10" of rain.

High winds caused extensive tree damage in the Clark County area on July 4.

August was above normal except for the northeastern part of the state. This was the third wettest August for the west-central region.

September was also noticeably above normal statewide, making it the second wettest in the past 121 years. Eastern Ohio received remnants of hurricane Isabel on September 19. Precipitation for the calendar year was above normal by the end of September.

An example of how wet 2003 was in some areas of Ohio is affected by the fact that 51.14 inches of rain reported by the National Weather Service at the Akron-Canton Airport in northeastern Ohio made 2003 the third wettest year on record.

The wet weather contributed to infectious disease problems on plants. The period of leaf wetness was a factor in many parts of the state.

Table 1. Statewide Precipitation January through September 2003.

Month	Average Inches Precipitation	Above or Below Normal
January	1.73	-0.84
February	3.01	+0.75
March	2.23	-0.94
April	2.48	-1.10
May	6.66	+2.75
June	3.93	+0.08
July	6.91	+2.83
August	4.78	+1.34
September	6.10	+3.15

Source: Data from Ohio Department of Natural Resources – *Monthly Water Inventory Reports.*

Temperature

Overall, temperatures were cooler than last year (2002). For instance, Cincinnati had 37 days over 90°F last year and only five this year; Columbus had 30 in 2002 and five this year; and Cleveland had 21 in 2002 and five this year.

A final note, these statistics are averages and are obtained from Department of Natural Resources sites. Rainfall is variable across the state, and the data that one uses depends upon the collection site.

Table 2. Temperature in Selected Cities January through September 2003.

Month	Cleveland		Columbus		Cincinnati	
	Avg. Temp. F°	Departure F°	Avg. Temp. F°	Departure F°	Avg. Temp. F°	Departure F°
April	48.9	1.3	54.9	2.9	55.7	2.0
May	57.8	-0.7	60.8	-1.8	61.8	-1.9
June	66.9	-0.6	67.3	-3.9	67.2	-4.8
July	72.6	0.6	73.4	-1.7	73.9	-2.4
August	73.3	3.0	73.6	0.2	74.6	0.2
September	63.7	0.4	64.4	-2.1	64.8	-2.6

Source: Average temperature is an average of all high and low temperatures recorded daily for the given location.
Data for Cleveland were taken from: www.csuohio.edu/nws/climate/cle/climatecle.html
Data for Columbus and Cincinnati were take from: www.nws.noaa.gov/er/iln/lcdpage.htm

Table 3. Number of Days 90°F and Above April through September 2003.

Location	June	July	August	September	Season Total
Cleveland	2	2	1	0	5
Columbus	3	1	0	1	5
Cincinnati	0	3	2	0	5

Useful web sites for weather-related topics are listed here:

Ohio Department of Natural Resources Division of Water, monthly water inventory report:

http://www.dnr.state.oh.us/water/

National Oceanic and Atmosphere Administration (NPOAA) drought report:

http://www.drought.noaa.gov/

USDA Topsoil Moisture Chart:

http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/topsoil.html

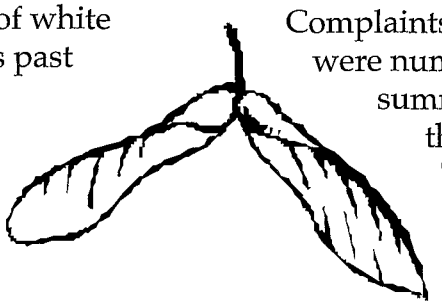
Degree day, phenology update for Ohio:

http://www.oardc.ohio-state.edu/gdd

Environmental Problems of Ornamental Plants

Reports of winter injury occurred in April. Plants that had some type of winter-related injury noted include white pine, fir, cotoneaster, pieris, rhododendron, viburnum, and evergreen euounymus. Younger trees exhibited frost cracks, usually on the south and west side.

Ohioans noticed browning of white pines along the freeway this past spring. Damage was from heavy use of road salt because of snow and ice this past winter. Other species that showed damage to some extent were spruces, yews, and junipers that were near roads, sidewalks, or driveways where salt was used.



There were numerous observations in May of red maples with new shoots that wilted and had blackened leaves. The cause of the problem was not determined, but it was suggested that it might have been due to delayed cold-temperature injury. The hypothesis is that cold temperature damage occurred earlier in the spring and did not show up until leaves expanded and required adequate water to continue development and to survive. No serious effects were reported.

Maple seed production in the spring was heavier than usual and resulted in numerous complaints and phone calls to Extension offices. A warm fall in 2002 followed by perfect conditions this year for bloom and pollination resulted in heavy seed production. There was a lack of normal leaf development while seeds matured, making the brown seeds quite obvious. When seeds turned brown, many misinterpreted brown plant tissue in the tree as a sign of plant problems.

Most maples produce their seeds in the fall; however, red and silver maples produce their seeds in the spring. Their seeds do not require dormancy to germinate; they can sprout right away, producing seedlings. Therefore, when seeds germinated this spring, new seedling trees were discovered everywhere, including flower beds, lawns, gardens, and even downspouts.

Complaints of vegetables not maturing were numerous due to the cooler summer temperatures and higher than normal rainfall amounts. Tomatoes, peppers, and other heat-loving vegetables were slow in forming fruits and ripening.

Arborvitaes had heavier than normal cone set this year, making them almost unsaleable at the nurseries. Customers did not like the brown appearance. Some reported that cones were so heavy that the plants were bending to the ground. There is no research as to why this occurred, but some speculated that it was due to weather conditions.

There were reports of earlier than usual fall coloration in early September with maples the most notable trees showing color. Early fall color was not a definitive means of detecting problems in trees, but it did indicate that a tree may be stressed.

Some of the environmental factors that should be considered are too much or too little water, insect and disease problems, low nutrient availability, improper planting depth, or the wrong environmental conditions for the species.

Trees required pruning attention due to severe storms and winds throughout the summer as well as a severe ice storm in February. Owners determined first

whether to salvage or remove damaged trees. Remaining trees required pruning. Splits and cracks in trunks and major limbs may lead to structural instability, as well as uplifted soil or disturbed roots.

If the tree appeared relatively sound in structural integrity, then damaged limbs and branches required pruning. Pruning large trees should be left to professional, certified arborists.

Trees should be carefully pruned and not topped. Topping removes most of the canopy, leaving mostly branch stubs. These stubs are more prone to decay and may attract wood boring insects. Follow proper pruning practices to ensure continued tree health.

For additional information on pruning, refer to the article *20 Questions of Pruning* later in this publication.

References

1. Dr. Jeffery Rogers, State Climatologist, with the State Climatologist's Office for Ohio, provides current and archived weather information for several locations in the state. This information is available at:

   http://www.geography.ohio-state.edu/faculty/rogers/statclim.html

2. The National Weather Service Forecast Office, Cleveland, Ohio.

   http://www.erh.noaa.gov/cle/climate/cle/climatecle.html

3. The National Weather Service Forecast Office, Wilmington, Ohio.

   http://www.erh.noaa.gov/er/iln/lcdpage.htm

4. The Buckeye Yard and Garden online is available at:

   bygl.osu.edu

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Insect and Mite Activity Noted in Ohio Nurseries and Landscapes: 2003

Joseph F. Boggs, Curtis E. Young, David J. Shetlar, Barbara Bloetscher; Amy K. Stone, David J. Goerig, Timothy J. Malinich, David E. Dyke, Erik A. Draper, Pamela J. Bennett, Gary Y. Gao, and James A. Chatfield

Summary

Gypsy moth *(Lymantria dispar)* populations were low this past season across the state, as were populations of eastern tent caterpillar *(Malacosoma americanum)* and fall webworm *(Hyphantria cunea)*. However, localized damaging infestations of yellow-necked caterpillar *(Datana ministra)* and bagworm *(Thyridopteryx ephemeraeformis)* were observed throughout the state. Mimosa webworm *(Homadaula anisocentra)* caused noticeable browning of honeylocusts in northeastern Ohio. Larch casebearer *(Coleophora laricella)* was common on its namesake in the southwestern and northeastern areas of the state.

A number of sawfly defoliators made their presence known including dusky birch sawfly *(Croesus latitarsus)*, hollyhock sawfly *(Neoptilia malvacearum)*, European pine sawfly *(Neodiprion sertifer)*, and white pine sawfly *(N. pinetum)*. Boxwood leafminer *(Monarthropalpus flavus)* and oak shothole leafminer *(Agromyza viridula)* were also common pests.

High grasshopper populations were reported throughout the state, which was unusual given the generally wet conditions present for much of the season. The two most common species observed were the redlegged grasshopper *(Melanoplus femur-rubrum)* and the differential grasshopper *(M. differentialis)*.

The non-native emerald ash borer *(Agrilus planipennis)* was the most significant borer found in Ohio during the 2003 season. However, white pine weevil *(Pissodes strobi)*, Asian ambrosia beetle *(Xylosandrus crassiusculus)*, and the hornbeam version of twolined chestnut borer *(Agrilus bilineatus carpini)* were also observed.

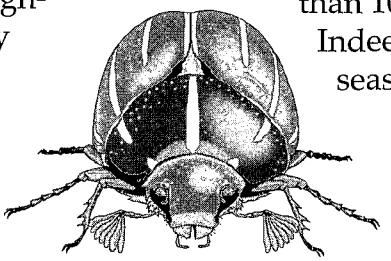
A number of sucking insects appeared in significant numbers in Ohio including potato leafhopper *(Empoasca fabae)*, yucca plant bug *(Halticotoma valida)*, spiny witchhazel aphid *(Hamamelistes spinosus)*, and pine bark adelgid *(Pineus strobi)*.

Joseph F. Boggs, Ohio State University Extension, Hamilton County/South District; Curtis E. Young, Ohio State University Extension, Allen County; David J. Shetlar, Ohio State University Extension/Ohio Agriculture Research and Development Center/Entomology; Barbara Bloetscher, Ohio State University Extension/C. Wayne Ellett Plant and Pest Diagnostic Clinic/Entomology; Amy K. Stone, Ohio State University Extension, Lucas County; David Goerig, Ohio State University Extension, Mahoning County; Timothy Malinich, Ohio State University Extension, Cuyahoga County; David Dyke, Ohio State University Extension, Hamilton County; Erik A. Draper, Ohio State University Extension, Geauga County; Pamela J. Bennett, Ohio State University Extension, Clark County; Gary Y. Gao, Ohio State University Extension, Clermont County; James A. Chatfield, Ohio State University Extension/North District/Horticulture and Crop Science.

Several species of lace bugs were also very evident, particularly oak lace bug *(Corythuca arcuata)*, hawthorn lace bug *(C. cydoniae)*, and azalea lace bug *(Stephanitis pyrioides)*.

Spruce spider mite populations were low this past season owing to heavy spring rains. However, eriophyid rust mites, including spruce rust mite *(Nalepella halourga)*, hemlock rust mite *(N. tsugifolia)*, baldcypress rust mite *(Epitrimerus taxodii)*, and the privet rust mite *(Aculus ligustri)*, produced damaging localized infestations in many areas of the state.

Japanese beetle *(Popillia japonica)* populations were generally low throughout the state. However, a heavy emergence of European chafer *(Rhizotrogus majalis)* adults were observed in northeastern Ohio. Bluegrass billbug *(Sphenophorus parvulus)* and hairy chinch bugs *(Blissus leucopterus)* were common in a number of areas of the state.



The Oriental chestnut gall wasp *(Dryocosmus kuriphilus)* was found for the first time in Ohio this past season, and Oriental beetle *(Anomala (= Exomala) orientalis)* was found for the first time in central Ohio, far from its previously known sites in the extreme northeastern part of the state.

Introduction

Insect and mite activities reported in 2003 in Ohio State University Extension's *Buckeye Yard and Garden Line (BYGL)* and *Pest Evaluation and Suppression Techniques (PEST)* newsletters as well as other sources are summarized and compared to previous seasons. Unusual insect and mite activity is also reported.

General Defoliators

Gypsy Moth

Gypsy moth *(Lymantria dispar)* eggs began to hatch in northwestern Ohio the last week of April. Larval development was completed and pupation began to occur in that part of the state the first week of July. Populations of this general defoliator were low this past season across the state.

The Ohio Department of Agriculture (ODA) only treated nine blocks, in six counties, totaling 2,126 acres, as part of its suppression program. Last year's suppression-treatment blocks totaled more than 10,000 acres in 21 counties. Indeed, acreage sprayed this season was far less than that sprayed as recently as five years ago. However, just as wet weather contributed to a general decline in gypsy moth populations, several dry springs could lead to a rebound in the moth populations.

Yellownecked Caterpillar

Populations of yellownecked caterpillar *(Datana ministra)* were observed in central and southern Ohio, with some locally heavy infestations. These caterpillars feed in colonies, with each group focusing its collective gastric attention upon a single branch. They possess a cosmopolitan palate, feasting upon walnut, hickory, and oak as well as crabapple, cherry, maple, elm, beech, linden, birch, black locust, azalea, sumac, and boxwood.

Yellownecked caterpillars pass through three distinct color phases during their development, meaning that the larvae change color patterns. This trait may present an identification challenge. First-instar caterpillars are copper-colored with

no distinct lines. The next color phase begins with the second-instar caterpillars. They have distinct alternating longitudinal yellow and orangish-red lines. Last instar caterpillars show the third-color phase with caterpillars having alternating longitudinal black and yellow lines.

All instars share some common traits. They are all covered with white to yellowish-white hairs, although the hairs are most evident during the third color phase. All instars have black head capsules and a characteristic bright orangish-yellow segment behind the head, from which this insect gets its common name.

Finally, regardless of instar stage, when the caterpillars are disturbed, they lift their heads and tails, causing their bodies to become U-shaped.

Yellownecks have two, and possibly three, generations per year. Since they feed in colonies, the caterpillars generally defoliate their hosts one branch at a time, unless populations are high and numerous colonies occur on a single host. With multiple generations, this caterpillar can potentially completely defoliate its host in one season.

Giant Silkworm Moth Caterpillars

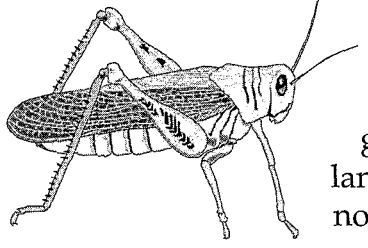
A considerable number of caterpillars of several species of giant silkworm moths (Family Saturniidae) were observed during the 2003 season in Ohio, including hickory horned devil *(Citheronia regalis)*, polyphemus moth *(Antheraea polyphemus)*, cecropia moth *(Hyalophora cecropia)*, promethia moth *(Callosamia promethea)*, and imperial moth *(Eacles imperialis)*. Although these silkworm moths feed as defoliators, their solitary nature and generally low numbers mean that they seldom cause significant injury to their host plants, so control measures are not recommended.

Indeed, these caterpillars eventually develop into some of the most beautiful moths found in Ohio. Their numbers this past season seemed to represent a reversal of a general decline of these moths over the past several years that has been attributed to the depredations of parasitoids imported to control gypsy moth. *BYGL*ers speculated that the rise of the silkworm moths may be connected to low populations of gypsy moth and a subsequent reduction in multi-host parasitoids associated with gypsy moths.

Grasshoppers

Grasshoppers were abundant during the 2003 season throughout Ohio. This was surprising since high numbers of grasshoppers tend to be associated with dry soils, a rare occurrence this season in most areas of the state.

The two most common species observed were the redlegged grasshopper *(Melanoplus femur-rubrum)* and the differential grasshopper *(M. differentialis)*. Nymphs of both species were found in great abundance along roadsides, edges of fields, and in other grassy areas, as well as in Ohio landscapes where they caused noticeable damage to a wide range of plants. Extension agents in the southern portion of the state even observed nymphs and adults chewing holes in nylon window screening. This is not an uncommon behavior when populations are high.



Female grasshoppers lay eggs in the soil in egg-shaped, pod-like egg masses. Each egg mass consists of 20 to 120 eggs that are cemented together. The females

are capable of producing eight to 25 egg masses, depending upon the species. Thus, populations can expand rapidly. However, numerous predators, parasites, and pathogens tend to keep populations low during normal years. Indeed, fungal infections of egg masses are a common occurrence during wet seasons. *BYGL*ers were at a loss to explain the high populations.

Grasshopper infestations around homes can be controlled with an application of an insecticide labeled for use as a perimeter spray. Such applications are made around the outside of homes from the foundation to a few feet away from the foundation. Care should be taken not to spray plants, unless the insecticide is labeled for use on the plants. Of course, as with all pesticide applications, read and follow label directions.

Spraying window and door screens is not recommended since air passing through the screens could carry the insecticide into the home. To prevent damage to screens, nylon screens can be replaced with aluminum screens.

Sawfly Defoliators

Sawflies vs. Caterpillars

A number of *BYGL* reports this season centered on failed attempts by home gardeners and landscapers to control "caterpillars" using the naturally occurring insecticidal bacterium *Bacillus thuringiensis* or *Bt.* Of course, the caterpillars were actually caterpillar-like sawfly larvae.

While certain strains of *Bt* are very effective against caterpillars, which are the immature stage of moths and butterflies (Order Lepidoptera), sawflies belong to the Order Hymenoptera *(e.g.,* bees, wasps, etc.) which are not affected by *Bt.* It is essential to determine the identity of the larvae before using *Bt.*

There is a handy way to tell the difference between caterpillars and sawfly larvae. Starting at the front, the larvae of both types of insects have three pairs of hardened (sclerotized) legs beneath the first three segments immediately behind the head capsule. These are called *thoracic legs,* and they will remain on the insect into the adult stage.

Next, the larvae have pairs of fleshy legs beneath the abdominal segments. These are called *prolegs* and will be lost when the larvae pupate and the insects emerge as adults. Butterfly and moth caterpillars have two to five pairs of prolegs. Sawfly larvae have six to nine pairs.

Use your hand to help remember this "rule:" If the larvae have the same number of prolegs, or less, as the number of fingers on your hand, they are caterpillars. If they have more prolegs than the number of fingers on your hand, they are sawfly larvae.

Dusky Birch Sawfly

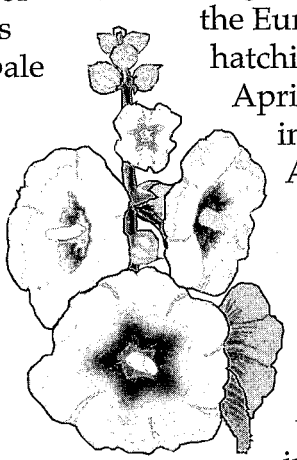
Significant populations of dusky birch sawfly *(Croesus latitarsus)* were observed feeding on the birches in southwestern Ohio. The larvae feed on all species of birch, but seem particularly fond of gray birch *(Betula populifolia).* Early instars are grayish-green with indistinct black spots. Middle-instar larvae are greenish-gray with distinct black spots, and late instars are yellowish-green with black spots. All instars have shiny black head capsules, and they feed in colonies, lined up head-to-tail along leaf margins.

When disturbed, larvae hang on with their prolegs and form their bodies into

a distinct S-shape, which is another great self-identifier for this insect — S for sawfly! Dusky birch sawflies have two generations in Ohio, so trees can be heavily defoliated during the season.

Hollyhock Sawfly

As with past seasons, the mid- to late summer larval feeding activity of the hollyhock sawfly *(Neoptilia malvacearum)* generated a considerable number of telephone calls to Extension offices throughout Ohio. The larvae are pale green with black-colored heads, and they have tiny black-colored spines on each body segment. They are leaf skeletonizers that feed on the lower leaf surface of the foliage, leaving behind the upper surface and the main leaf veins. Hollyhock sawfly larvae frequently feed in groups.



The adults are small (3/16 inch), black-colored, fly-like insects with a reddish-brown thorax. The adult sawflies are interesting because their antennae split almost to the base, so they appear to have four antennae instead of two. This sawfly can have as many as three generations per year; however, control is not difficult. Carbaryl *(e.g.,* Sevin) is very effective, but it should be applied as soon as the larvae are discovered.

European Pine Sawfly

European pine sawfly *(Neodiprion sertifer)* is a perennial spring pest in Ohio of Scotch, mugo, red, jack, Table Mountain, and Swiss mountain pine, with white and Austrian pines serving as occasional hosts. During the 2003 season, only highly localized pockets of this sawfly were observed with infestations often confined to single trees in landscapes. Indeed, damage was often made more apparent by the stark contrast with unaffected conifers near the infested tree.

The sawfly has one generation per year. It spends the winter in the egg stage. Females use their saw-like ovipositors to deposit eggs in envelope-like slits cut into needles. Egg scars become light yellow, and rows of these scars are usually very evident on infested trees during the winter. Overwintered eggs of the European sawfly were observed hatching in southwestern Ohio on April 7, 2003. Egg hatch was observed in the central part of the state on April 12, 2003.

The larvae are caterpillar-like in appearance and have bulbous, shiny-black head capsules. Early instars are mostly grayish-green, causing them to blend with surrounding needles. Later instars develop faint grayish-white longitudinal strips. The first instar larvae can only eat the needle surface, causing needles to turn brown and wilt, appearing straw-like.

As the larvae grow, they eventually consume entire needles. All instars feed in groups and can rapidly defoliate branches. However, since feeding is confined to last year's needles and ceases before the new growth emerges, the impact on overall plant health is considered minimal.

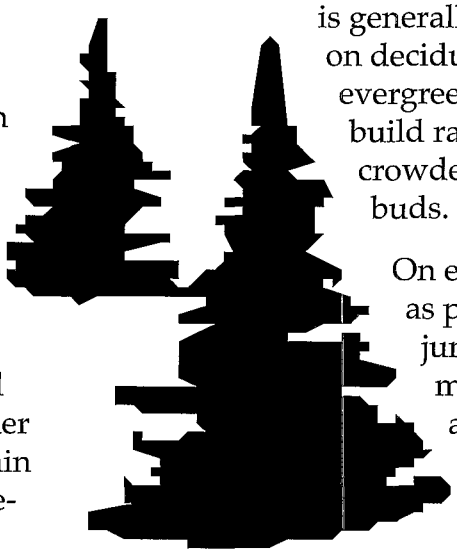
White Pine Sawfly

White pine sawfly *(N. pinetum)* is a more serious pest than European pine sawfly, because it feeds late in the season on both old and new needles, and it may have more than one generation per year. High populations and considerable damage to white pine were observed in western Ohio, with localized populations observed

in the southwestern part of the state. The sawfly prefers eastern white pine but may occasionally be found on mugo and red pines.

Adult wasps emerge in spring, mate, and the females deposit eggs in the needles. Larvae are present between mid-June and late July, and sometimes for a second generation between mid-August and late September.

The black-headed larvae are yellow to white in color with four rows of square black spots running along the length of the body. Mature larvae migrate down, or drop out of the tree, to the soil or duff under the tree, where they spin brown, oval cocoons. The larvae will either pupate immediately or remain larvae and overwinter as pre-pupae.



White pine sawfly feeding damage can result in branch or tree mortality following complete defoliation. Thus, management may be required when populations are large and the potential for extensive defoliation is high.

Nest-Making Caterpillars

Bagworm

While bagworm *(Thyridopteryx ephemeraeformis)* populations throughout the state were not consistently high in 2003, heavy localized infestations were a common occurrence, particularly in the western half of the state. Indeed, damaging populations were observed in the Toledo area, a part of the state where this moth has seldom been found in the past.

Bagworm is well-known for the injury it can cause to several species of evergreens, especially arborvitae, juniper, spruce, and pine. It is somewhat less well-known for its activities on deciduous trees and shrubs.

According to the literature, bagworm caterpillars can feed and develop on more than 120 plant species, although injury is generally not nearly as severe on deciduous plants compared to evergreens. Heavy populations can build rapidly on all hosts, and, if crowded, the bagworms may eat buds.

On evergreen hosts such as pines, arborvitae, and junipers, this feeding activity may cause branch dieback and open, dead areas. If defoliation is excessive, plants may die the following season.

Landscapes should be monitored closely for this pest, especially on plants infested last season. If there are just a few bagworms on a plant, they can be handpicked and destroyed. *Bacillus thuringiensis* or *Bt (e.g.,* Dipel, Thuricide, or Caterpillar Attack) is effective against bagworm when bags are less than 3/8" in length. Other properly labeled insecticides will have to be used if the caterpillars are allowed to get larger.

Mimosa Webworm

There were reports of heavy localized infestations of mimosa webworm *(Homadaula anisocentra)* in northern and central Ohio on honeylocust during the 2003 season.

Larvae of this moth feed gregariously within webs spun over the foliage. They feed primarily as skeletonizers on the

lower leaf surface, and the damage causes leaves to turn orangish-brown and appear fire-scorched. Unlike with other web-makers, these clusters of "torched" leaves, rather than the actual webbing, usually draw attention to an infestation.

There are two to three generations per season in Ohio, and they typically overlap so that larvae may be present anytime from June into September.

Also, female moths often deposit their eggs on nests from which they developed, so nests continue to expand and become more dense with silk and spent leaves from one generation to the next. Once nests become large and tightly woven, control applications may fail to penetrate the thick webbing.

The best time to control the caterpillars is early in the season, when nests are small and consist of loosely woven silk. Effective early-season materials include *Bacillus thuringiensis (Bt)* as well as other insecticides listed in Ohio State University Extension Bulletin 504, *Insect and Mite Control on Woody Ornamentals and Herbaceous Perennials.*

Eastern Tent Caterpillar

Overwintered eggs of eastern tent caterpillar *(Malacosoma americanum)* hatched in the Cincinnati area by the end of March, and small nests constructed in branch forks were evident the first week of April. However, as with the rest of the state, overall populations were relatively low with only an occasional significant infestation.

Fall Webworm

Likewise, fall webworms *(Hyphantria cunea)* were also something of a no-show during the 2003 season. Despite numerous reports of significant numbers of first-generation nests, the second generation failed to make the curtain call.

First-generation nests are usually very small, and inconsequential, owing to small numbers of caterpillars. Truly impressive nests enveloping large areas of leaves at the ends of tree branches are constructed by the greater caterpillar work force available in the second generation.

Larch Casebearer

The larch casebearer *(Coleophora laricella)* has generally been relegated to the list of landscape oddities in past seasons. However, significant populations were observed in southwestern and northeastern Ohio during the 2003 season.

The overwintered larvae of this small moth (wing span is only 1/3") get their name from the cigar-shaped cases they construct. They line mined-out needles with silk, insert their abdomen, and carry the dead needles around for protection.

The resulting unusual image is that of walking dead needles. When disturbed, larvae may attach a strand of silk to the tree and drop on silky threads towards the ground.

Damage includes burned or bleached needles that may give the trees a white/silvery appearance. Heavy infestations may result in complete defoliation of the tree. There are two generations per year, with the second generation generally appearing in mid- to late July.

Although control measures have generally not been recommended in past seasons, trees that were heavily infested during the 2003 season should be closely monitored next year.

Leafminers

Boxwood Leafminer

An unusual phenomenon was observed (heard) last season involving boxwood leafminer *(Monarthropalpus flavus).* In late April, landscape managers and home gardeners in central and southern Ohio began reporting that they were hearing faintly audible crinkling or rustling noises emanating from boxwoods.

Thorough examinations of the shrubs and extensive observations failed to reveal birds, or rodents, or any other familiar noise-maker cavorting among the branches or under leaf debris. Indeed, the sounds seemed to come from the plants themselves!

It was eventually determined that boxwood leafminer pupae were the noisemakers. This tiny fly spends the winter in the larval stage in blister-like leaf mines. As spring approaches, the orangish-yellow larvae resume feeding for a short period, then pupate. The pupae are also orangish-yellow in color, and they are very active wigglers.

They not only wiggle about within the leaf mines, but as adult emergence approaches, the pupae wiggle themselves partially out of the mines. This generally occurs at about the same time weigela begins to bloom. This wiggling pupal activity was considered to be the source of the faint crinkling sounds.

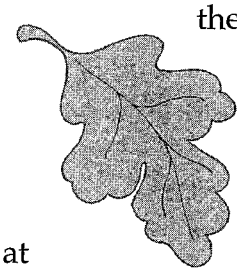
Unusual noises aside, this leafminer can become a very serious pest. Larvae feed on parenchyma tissue within leaves and they may produce multiple blister mines. The mines turn yellowish-brown in the late spring, and damaged leaves are often evident throughout the summer. Heavy infestations may weaken plants by causing severe branch dieback.

Adults generally begin to emerge in early May and can be seen flittering among the leaves of boxwoods. The small, gnat-like flies have abdomens that are about the same orangish-yellow color as the larvae and pupae.

While adulticide applications may provide some reduction in populations, the best control options target the larvae. Larval control options to prevent mines include applications of imidacloprid *(e.g.,* Merit) made in the fall or in the spring as a soil drench, or acephate *(e.g.,* Orthene) as a foliar spray in mid-to-late May.

Oak Shothole Leafminer

The dramatic handiwork of the oak shothole leafminer *(Agromyza viridula)* was once again very evident this past season on oaks in many areas of the state, particularly on bur and chinkapin oaks. This tiny fly is related to the holly and inkberry leafminers.



Females wing their way to oak leaves just as the leaves begin to emerge from the bud. Unable to penetrate leaves with their lapping mouthparts, the females use their sharp, flexible ovipositors to puncture the new leaves. They then lap up the sap issuing forth from the wounds and insert eggs into these feeding holes, one egg per wound.

Larvae feed as leafminers and develop rapidly, usually before the leaves have fully expanded. The mature larvae drop from the mines to pupate, leaving behind a circular area of necrotic tissue that falls from the leaf.

These small holes enlarge as the leaves expand. The holes may remain distinct, imparting a Swiss-cheese appearance to the leaves, or coalesce, giving the appearance that large sections of the

have been removed. This may cause the leaves to look tattered. Indeed, it has been speculated that this insect could account for some of the symptoms generally ascribed to the leaf injury phenomenon known as oak tatters.

It has been reported that oak shothole leafminer has several generations per year. However, only the first generation produces appreciable damage since it occurs when the greatest number of new leaves are available for feeding and oviposition. Regardless, the damage is seldom severe enough to cause serious harm to the tree, so controls are generally not recommended.

Borers

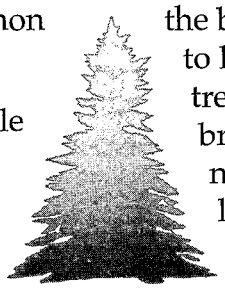
Emerald Ash Borer

In 2003, the non-native emerald ash borer *(Agrilus planipennis)* was found in five counties in Ohio. Four of the infestations were found in counties located in the northwestern part of the state, near the area in Michigan where this insect was first discovered in the United States. Franklin County, in the central part of the state, was the fifth county where an infestation was discovered.

By far, this was the most significant borer found in the state this past season. The emerald ash borer is thoroughly discussed in a comprehensive article included in this Special Circular titled *Emerald Ash Borer: The Beginning of the End of Ash in North America?*

White Pine Weevil

White pine weevil *(Pissodes strobi)* was commonly found in central and western Ohio in 2003, although the most significant damage was observed in the northeastern part of the state.



Overwintered females lay eggs in conifer terminals in the spring. The resulting white, legless, slightly curved, grub-like larvae tunnel downward just beneath the bark until pupation occurs in mid- to late summer. The tops of infested trees eventually become wilted, turn brown, and die. Tunneling often does not progress past the top two lateral limb whorls; however, on small trees, larvae may tunnel to the base of the main stem, killing the entire tree.

As the common name implies, the weevil infests white pine. However, it will also attack Scotch, jack, red, and pitch pine, as well as Douglas-fir, Colorado blue, and white spruce. Although the weevil has a traditional range that includes all of Ohio, it has been most prevalent in the northern and central parts of the state. White pine weevil has long been a serious Christmas tree production pest, but it is rapidly becoming a very significant nursery and landscape pest.

Look for dead or dying conifer tops. Main leaders are often curved into a shepherd's crook. Larval feeding activity causes the bark to darken and become paper-thin, and to appear slightly sunken. Removing the bark will reveal groove-like tunnels filled with dark, moist material, as well as white slivers of wood.

Larvae tunnel downwards, so they are usually found at the lower ends of the tunnels. Pupation occurs within 1/2"-long oval-shaped "chip cocoons" consisting of white excelsior-like material that is tightly bundled into depressions excavated into the surface of the xylem. There is one generation per year.

Management of the weevil includes insecticide applications in the spring to prevent egg laying and the removal and destruction of infested terminals later in

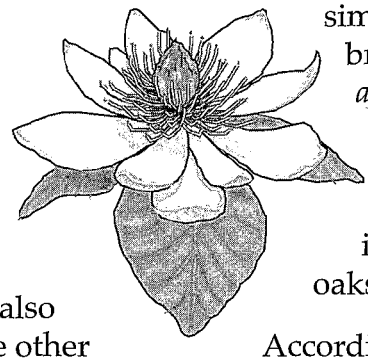
the season to reduce adult populations. Spring insecticide applications can be best targeted using adult monitoring traps.

These traps were researched and perfected by Rayanne Lehman, Pennsylvania Department of Agriculture, and are based on the Tedders Trap sold by Gempler's Supply (1-800-382-8473, Cat. No. R01960) to monitor for plum curculio and pecan weevil. The traps must be modified to use them for detecting white pine weevil.

Instructions are provided by Lehman at the following web site (in pdf file format): **http://ctrees.cas.psu.edu/pdfs/whitepinewvtraps.pdf**

Asian Ambrosia Beetle

Classic evidence of larval activity of the Asian ambrosia beetle *(Xylosandrus crassiusculus)* was once again observed this past season on small caliper magnolias in nurseries in northeastern Ohio. The trees were festooned with tan-colored toothpick-like spines of boring dust protruding from small holes in the bark.



This normally southern pest was found last year for the first time in Ohio nurseries. It was primarily found on sweetbay magnolia, but it will also infest oaks and cherries. Unlike other ambrosia beetles that attack stressed plants, this beetle attacks healthy plants as well as stressed plants. The beetle also shows a distinct preference for small caliper trees.

The tiny (approximately 2/16" long), dark-brown beetles feed in the xylem and pith where they introduce the ambrosia fungus into the wood. Making a cut a few days after the beetle has entered the plant will expose the fungus; it is very easy to see on the cut surface. The fungus is white, soft, and hairy and continues to grow through the xylem, disrupting vascular flow. Branches or the entire tree may eventually die from the fungus and the beetle damage.

The adults and larvae bore into twigs, branches, or small-caliper trunks and make a tiny entrance and exit hole. They excavate tunnels and introduce the ambrosia fungus, upon which they feed.

Frass is exuded as they bore and clings together to produce the toothpick-like spines. Wind and rain may knock the protruding frass off infested trees, resulting in an accumulation of frass at the base of the tree. Controls include a residual bark spray at four-week intervals throughout the growing season.

Hornbeam Borer

Hornbeams were observed this past season in Ohio exhibiting distinct horizontal ridges on the trunks, similar to those produced by bronze birch borer *(Agrilus anxius)* on birches. The culprit was the twolined chestnut borer *(A. bilineatus)*. However, this is not the same beetle that is most often associated with oaks.

According to current taxonomic positioning, there are two subspecies of the twolined chestnut borer. The subspecies *A. bilineatus bileneatus* attacks oaks and chestnuts, and the subspecies *A. bilineatus carpini* attacks hornbeams (both *Carpinus* and *Ostrya)*, as well as beeches.

Host feeding preference studies conducted on beetles collected from hornbeams indicated that the adult beetles had a distinct preference for hornbeam foliage. Indeed, they would not feed on oak

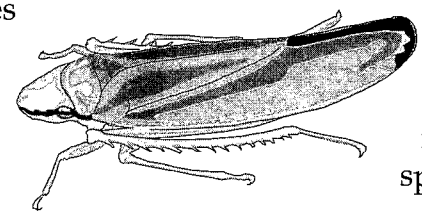
foliage, a host that is preferred by adults of the other subspecies.

The hornbeam beetles also appear to have a deeper metallic color, almost metallic blue, and the two faint longitudinal stripes were less evident than on the oak/chestnut subspecies.

Petiole Borers

The two petiole borers associated with maples and buckeyes/horsechestnuts were once again very active this past season in Ohio. The moth *Proteoteras aesculuana,* a petiole borer with no common name, produced minor, but often conspicuous damage to buckeyes and horsechestnuts.

Larvae bore into leaf petioles, causing the new leaves to turn black and droop. Symptoms superficially resemble frost or freeze damage. Look for off-colored, drooping leaves, and a single small hole in the petiole. Small quantities of frass may hang from the hole.



There may be two generations per year, so damage may be observed late in the season. This insect seldom causes significant leaf loss, so no control recommendations are advised.

The maple petiole borer *(Caulocampus acericaulis)* is a sawfly that bores into the maple petioles. Unlike the petiole boring moth on buckeyes/horsechestnuts, affected maple leaves usually fall from the tree. Heavy leaf drop in May often signals an infestation of this insect.

The tiny sawfly larvae tunnel out the inner tissues of the petiole. This causes the leaves to turn brown, droop, and the petioles to break a short distance from the leaf blade. Larvae remain inside the portion of the petiole attached to the twig, so raking and destroying fallen leaves will not reduce the population.

There is only one generation per year and damage is seldom severe enough to cause serious harm to the tree.

Sucking Insects

Potato Leafhopper

Potato leafhopper *(Empoasca fabae)* activity on nursery and landscape trees was very evident in Ohio during the 2003 season, particularly on maples in the central and northern parts of the state. This insect cannot overwinter in Ohio but is annually reintroduced into the state by prevailing winds blowing from the south.

Potato leafhopper is highly attracted to leguminous hosts such as alfalfa, where populations can build rapidly. It is also attracted to vigorously growing Norway and sugar maples, basswood, beeches, birches, apples, chestnuts, redbuds, and other tree species.

Generally, leafhoppers blown from the southern United States first establish and build populations on alfalfa. The insects then move to trees with the first cutting of the alfalfa.

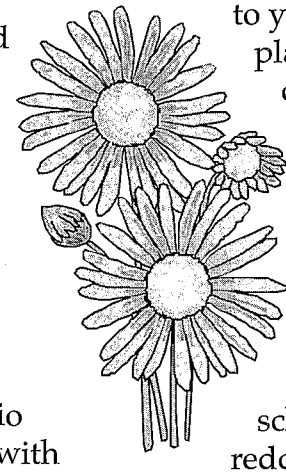
The leafhopper will feed on succulent tissues of both leaves and shoots of its host trees. Feeding on Norway and sugar maples can result in extensive foliage injury marked by blackened necrotic tissue and twisted leaves, severe stunting of new growth, and the development of multiple leaders.

Maples being propagated in nurseries should be carefully monitored. Trees

should be treated when leafhoppers are seen and treatments repeated as needed.

Leafhoppers began appearing in the Lima area in mid- to late May and in northeastern Ohio in late May. Very high populations and damage to maples, birch, beech, and basswood were reported in central Ohio in mid-June.

A second generation was reported in the Lima area in mid-June and in central Ohio in late June. Indeed, clouds of leafhoppers were seen swarming around street lights in the Columbus area the last week of June.



Lace Bugs

Lace bugs were very active in Ohio during the 2003 growing season, with oak lace bugs *(Corythuca arcuata)* on bur and chestnut oaks, hawthorn lace bugs *(C. cydoniae)* on hawthorns, and azalea lace bugs *(Stephanitis pyrioides)* on azaleas leading the pack.

Other lace bugs commonly observed included sycamore lace bug *(C. ciliata)*, walnut lace bug *(C. juglandis)*, and rhododendron lace bug *(S. rhododendri)*.

The unusual chrysanthemum lace bug *(C. marmorata)* that lives on both the upper and lower leaf surfaces of its host caused damage to several herbaceous perennials, particularly asters.

Yucca Plant Bug

The yucca plant bug *(Halticotoma valida)* continued to cause extensive damage in southwestern Ohio, but reports of high populations and significant injury were also made from locations in the central and northwestern parts of the state.

Intense feeding activity by this insect can cause considerable damage to foliage, and past occurrences of heavy populations have resulted in the demise of some yucca plantings in the Cincinnati area.

Small, white spots (stippling) produced by plant bug feeding may coalesce, causing the foliage to appear light-green to yellow. Also, blades on infested plants become covered with white cast skins and tarry waste specks — causing yucca to look yucky!

Adults of this small (3/16" long) native of the southwestern United States have black wings and orangish-red legs, head, thorax, and abdomen. The nymphs share this striking color scheme, but they appear more reddish in color since their black wing pads fail to cover their entire abdomen. Both adult and immature yucca plant bugs have an almost oval body shape.

This insect has multiple, overlapping generations, so populations can build rapidly. Insecticides labeled for use on yucca can provide effective control of this insect; however, applications should be made early in the season to prevent damage.

Spiny Witchhazel Aphid

Early-season infestations of the spiny witchhazel aphid *(Hamamelistes spinosus)* were reported throughout much of Ohio. The aphids reside on the underside of birch leaves, and their feeding activity induces the formation of characteristic leaf corrugations. All birches are susceptible; however, river birch appears to be a preferred host.

The aphid may alternate between birch and witchhazel, but it gets its name from the spiny, reddish-green, oblong bud galls

produced on witchhazel. The galls are not considered harmful to witchhazel, and the insect seldom causes serious damage to birch trees, beyond the effect on leaf aesthetics.

Pine Bark Adelgid

The pine bark adelgid *(Pineus strobi)* is potentially a very damaging pest to its conifer hosts. While this insect has not been uncommon in Ohio landscapes and nurseries in past seasons, it seemed particularly widespread during the 2003 season.

In May, overwintered females transform themselves into white puff-balls, making trunks of affected pine trees appear flocked. The adelgids may be found on many species of pines but seem to have a particular affinity for eastern white pine. High populations of this sucking insect can cause a gradual decline of infested trees.

The waxy, cottony material covering the females interferes with insecticide penetration. However, it is no match for a high-pressure stream of water, an alternative control approach.

The water dislodges and washes off the adelgids, sending them to the ground and certain doom. The water pressure available in most homes is sufficient to wash adelgids from small trees.

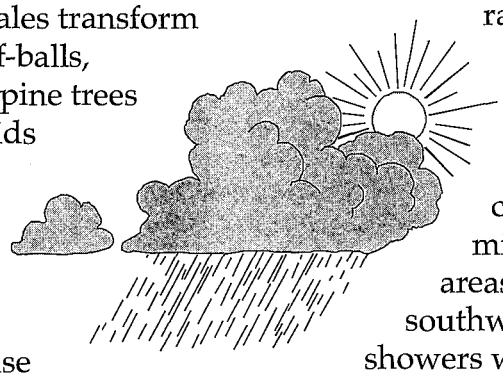
Larger trees may require the use of a pesticide sprayer, without the pesticide. Machines delivering high-pressure water for cleaning purposes are not recommended because they may damage bark.

Mites

Spruce Spider Mites

The spruce spider mite *(Oligonychus ununguis)* is a cool-season mite with damaging populations occurring in the spring and the fall. Damage symptoms include tiny yellow speckles, or stippling, on needles which may coalesce to intense yellowing or bronzing of the foliage.

During the 2003 season, damage from fall (2002) mite feeding activity began to appear in late spring to early summer throughout Ohio. However, heavy spring rains appeared to wash mites from trees, limiting spring feeding damage that would show up later in the summer. Rains continued to affect the mites during the fall in most areas of the state; however, in southwestern Ohio where rain showers were spotty and localized, damaging populations were observed.



Rust Mites

Damaging infestations of eriophyid rust mites were also observed in many areas of the state. Unlike the eriophyids that produce plant galls, rust mites are "free living," meaning they can survive on the surface of their host's foliage. Stippling and yellowing of needles on spruces and hemlocks are often attributed to spruce spider mites, but eriophyids may actually be the cause of the damage. Owing to their small size, eriophyids are often literally overlooked.

Eriophyid rust mites are very different from spruce spider mites. The eight-legged spruce spider mites are ovoid-shaped and apparent to the naked eye. When dislodged from the foliage using

the "beating-tray" method, spider mites can be made even more obvious by using a finger to lightly smash and smear the mites — mushed mites appear as greenish-brown streaks.

Eriophyid rust mites are carrot-shaped, and they only have four legs that appear to extend from their anterior end. Even more challenging, rust mites are almost microscopic. When magnified using a standard 10X hand lens, the mites look like dust particles. The magnification provided by a 30X dissecting microscope is required to see details.

Rust mite feeding behavior differs from spider mites; however, damage symptoms may appear almost indistinguishable from spider-mite injury unless viewed under high magnification.

The spruce rust mite *(Nalepella halourga)*, which feeds on spruces, and the hemlock rust mite *(N. tsugifolia)*, which feeds on hemlocks and firs, are the two most common rust mites found on conifers in Ohio. These are truly cool-season mites — they are active very late in the fall and early in the spring.

A major difference between rust mites and spider mites is that rust mites can be controlled using some standard insecticides, such as carbaryl *(e.g.,* Sevin). A 1% horticultural oil solution mixed with a properly labeled pyrethroid insecticide is also effective. However, oils may wash the "blue" off blue spruce.

Baldcypress rust mite *(Epitrimerus taxodii)* and the privet rust mite *(Aculus ligustri)* were both observed affecting their hosts this past season. Rasping damage by the baldcypress rust mite appears first as very fine spots, or stippling. The needles eventually become yellowish and then reddish brown or rusty in color. Inner needles are generally affected first.

Feeding activity of the privet rust mite causes privet leaves to become pitted and yellowish-brown; then they curl and turn brownish-black. Heavy populations can produce severe defoliation.

Pearleaf Blister Mite

Pearleaf blister mite *(Phytoptus pyri)* was a common occurrence on ornamental pears in southwestern and central Ohio, and localized populations seemed to be unusually heavy this year. Symptoms may superficially resemble other problems, such as fungal leaf diseases, and in extreme cases, even bacterial fireblight.

The microscopic carrot-shaped eriophyid mites feed between the upper and lower leaf surfaces, causing blisters to form on the upper leaf surface, and patches of brown-to-black necrotic tissue to form on the lower leaf surface.

The blisters are at first light-green, but later they turn pinkish-red and finally black. When mite populations are high, the entire leaf may blacken and droop.

Gall Makers

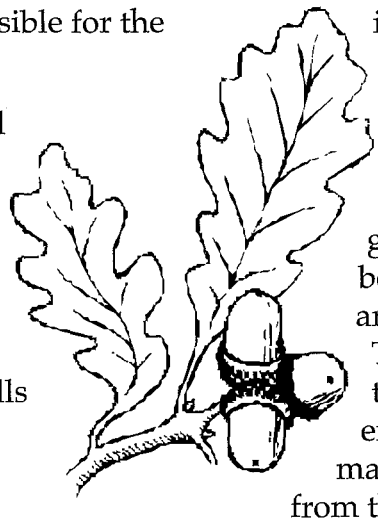
Galls produced by the usual suspects were once again common in Ohio during the 2003 growing season. However, one very unusual oak gall dominated galling reports.

Acorn Plum Galls

In mid- to late August, acorn plum galls were found in large numbers beneath red oaks in the Cincinnati and Dayton areas, as well as in and around Lima.

The galls grow from the sides of acorn caps. They are approximately 1" in diameter and may be rounded, or slightly plum-shaped. The general shape and

point of attachment are responsible for the common name of these galls.



Acorn plum galls are produced by the cynipid wasp, *Amphibolips prunus.* Gall aficionados may recognize that this genus includes the gall wasp *(A. confluenta),* which produces the more commonly found oak apple galls on red oaks. As with oak apple galls, acorn plum galls contain a single wasp larva housed in a seed-like cell located at the center of the gall.

Another common trait of the two galls is that once the wasp larvae complete their development, the "mature" galls detach from the host tree and drop to the ground.

As with most oak galls, the acorn plum gall causes no significant harm to oak hosts, so no controls are recommended. However, large numbers of these odd galls found beneath infested oaks may startle home gardeners.

The most striking feature of the acorn plum galls is their color. They have a tannish-brown surface that is shot-through with vibrant blood-red or purplish-red streaks and blotches.

The inside of the gall is densely fleshy, almost to the point of being "woody," making them difficult to slice open with a knife. However, if the galls are carefully cut, they ooze a purplish-red fluid that will stain fingers and clothing.

Indeed, this feature is shared with similar oak galls found in Europe and was exploited during the Middle Ages to produce ink. But, unlike most inks produced at the time that were based on a suspension of pigments, the fluid from oak galls is actually a dye — the color is produced by a chemical reaction involving tannic acid.

European ink makers found that the overall color of the gall extract will deepen and become darker when iron salts are mixed with the gall fluid. This color change occurs as the mixture oxidizes with exposure to air. This reaction may also be observed when iron from the blade of knives or pruners reacts with the tannic acid in the gall fluid. The oxidation and subsequent color change are very rapid.

Turf Pests

Japanese Beetle

Adult Japanese beetles *(Popillia japonica)* began to appear on schedule in southern Ohio in late June. However, the expected thundering herd failed to make an appearance in that area of the state, as well as in other areas. In general, it was a relatively quiet Japanese beetle season, although a few localized heavy infestations were observed.

Speculations regarding reasons for the low populations centered on heavy spring rains drowning pupae, and drought conditions during the 2002 season reducing egg survival. Grubs can easily climb up and hide on the soil surface in a drier location. However, the immobile pupae are unable to relocate themselves to dry soil, and studies have shown they die if submerged for over a week.

Studies have also shown that the year following a late-season drought often results in at least localized low Japanese (and other annual grub species) beetle populations. This explains why few grubs

or pupae have been found in some of the drier counties.

European Chafer

European chafer *(Rhizotrogus majalis)* appeared to have been much less affected by last season's drought, or this season's heavy rains. Northeastern Ohio once again experienced a significant emergence of European chafer adults. Mass mating flights of this beetle have become a common occurrence in late June in that part of the state in recent years.

Although the beetles do little damage to trees and shrubs, these chafers participate in spectacular mating flights. Beginning at sunset, swarms of the brown adult beetles hang in large groups from the lower branches of trees. As mating progresses, the preoccupied beetles lose their grip and fall to the ground. The adults separate, and the female eventually seeks moist organic soils in which to lay her eggs.

Eggs hatch in mid- to late July with second-instar grubs developing in early August. Best controls for European chafer grubs are achieved by treating from the latter part of July into early August with products containing imadacloprid or halofenozide. So far, this non-native beetle has only been found in the northeastern part of the state.

Bluegrass Billbug

As with the 2002 season, heavy localized infestations of bluegrass billbug *(Sphenophorus parvulus)* were again observed in central and southwestern Ohio. However, continued rains tended to mask damage produced by larvae feeding on stems and crowns.

Overwintered adults began appearing in late April in central Ohio, when Vanhoutte spirea and horsechestnut were in full bloom. By late June, larvae had reached third- or fourth-instar stages in that part of the state. These are the stages when the legless, grub-like larvae begin feeding on turfgrass crowns which can cause significant plant injury.

Billbug larvae will feed on any cultivar of Kentucky bluegrass, as well as perennial ryegrass and fescues if sufficient levels of endophytes are not high enough to kill or repel the billbugs. During normal seasons, billbug injury is often mistaken for summer drought dormancy.

Infestations can be diagnosed in mid-summer using the "tug test." Stems damaged by billbugs break off easily at the crown. A close examination will reveal that the stems are hollow and filled with whitish frass left by the larvae.

Preventive applications of imidacloprid in early May, or halofenozide in early June, will protect the turf from billbug injury.

Chinch Bugs

Hairy chinch bugs *(Blissus leucopterus)* were very active in the Dayton, Columbus, and Akron-Canton areas. The first sign of chinch bug feeding damage is that some leaves turn a purple color. These damaged leaves soon turn yellowish-orange.

Chinch bug damage may appear similar to symptoms associated with summer drought, and it is also sometimes mistaken for symptoms produced by certain turfgrass diseases such as dollar spot, leaf spot, or brown patch.

Studies conducted by Dave Shetlar have shown that imidacloprid *(e.g.,* Merit), bifenthrin *(e.g.,* Talstar), and deltamethrin *(e.g.,* DeltaGard) provided excellent control of an ongoing chinch bug infestation.

As with other top-feeding insects, incorporating endophyte-enhanced turfgrass cultivars into existing stands will also reduce chinch bug populations.

Household and Nuisance Pests

Asian Lady Beetle

Research conducted in recent years on the soybean aphid *(Aphis glycines)*, a pest of soybeans that was accidently introduced into the United States from Asia, revealed a strong connection between population numbers of this insect and populations of the multicolored Asian lady beetle *(Harmonia axyridis)*.

It appears the aphid serves as rich fodder for the lady beetle. Indeed, during the 2002 season, high soybean aphid populations failed to develop in Ohio, and populations of the lady beetle were correspondingly insignificant.

However, during the 2003 season, soybean aphid populations exploded with the result being that lady beetle populations also appear to be rebounding. Although reports of multicolored Asian lady beetles coming into Ohio homes in the fall seemed lower than in past outbreak years, they were certainly more common than during the fall of 2002.

Foreign Grain Beetle

In 2003, new home construction in Ohio achieved a record high. Consequently, encounters with the foreign grain beetle *(Ahasverus advena)* were also very common throughout the state.

The consistent connection between this beetle and newly constructed homes has caused some entomologists to propose that it be renamed *New House Beetle.*

The elongated, and slightly flattened, beetle is reddish-brown and about 1/16" long. It belongs to the same family (Cucujidae) as the saw-toothed grain beetle *(Oryzaephilus surinamensis).*

Indeed, it is nearly a dead-ringer for its toothy cousin but lacks the saw-toothed projections on the pronotum, which is the thoracic segment just behind the head.

Another important distinction is that the foreign grain beetle is seldom found feeding on grain, except for moldy grain. The insect belongs to a group of beetles known as fungus beetles, because the larvae feed on fungi.

The adult beetles are attracted to fungi growing on the surface of damp grain, or on damp plaster and drywall, as well as poorly seasoned wood. Damp sawdust within walls that is left behind during construction may also provide a good substrate for molds or mildews.

The beetles lay their eggs on the fungus-infested materials, and the larvae feed on the fungi. Typically, larval development continues as the new homes are being finished, and a new batch of homesteading beetles emerge shortly after the new homeowners move in.

The beetles are only a nuisance since they do not bite or damage wood, fabric, or other materials. They most frequently are associated with homes constructed during the summer months.

Populations found in homes tend to disappear after the initial adult emergence, unless air-tight construction techniques limit drying. Drying out newly constructed homes can be enhanced by increasing ventilation using fans and by using de-humidifiers.

New and Unusual

Oriental Chestnut Gall Wasp

The oriental chestnut gall wasp *(Dryocosmus kuriphilus)* was found during the 2003 season in samples of Chinese chestnut collected from a location near Akron. This is the first time this non-native cynipid wasp has been detected in Ohio.

The wasp is a native of Korea and Japan, and it has decimated Chinese chestnut orchards in Georgia since it was accidently introduced into the state in 1974 by way of infested cuttings. Indeed, this gall-making wasp has nearly eliminated the chestnut industry in that state.

Most of the biology and the impact information on this insect in North America has been developed from research conducted in Georgia. In that state, the 1/8"-long female wasps emerge the last week of May and the first week of June. So far, no males have been found in this species.

The females lay three to five eggs inside vegetative and flower buds. Buds may be targeted by multiple females and contain up to 25 eggs. Egg hatch occurs after about 40 days, and first-instar larvae develop slowly through the autumn and winter.

Larval development accelerates in the spring, and the immature wasps stimulate buds to form 1/3"- to 1/2"-long green or reddish-green oblong-shaped galls. The galls may contain portions of developing leaves, stems, petioles, and flowers. The oriental chestnut wasp has one generation per year in Georgia, Japan, and Korea.

Gall formation suppresses leaf and shoot growth and reduces fruit development. Trees that suffer multiple years of severe infestations may lose vigor and die. After adult emergence, galls dry out and become woody. They remain attached to the tree and unsightly for several years.

Efforts to suppress this wasp chemically have yielded highly variable results. Natural enemies have been imported into Georgia to help suppress this wasp, but populations continue to develop. Pruning and destroying infested plant material remains the most effective method of control.

Although infestations may expand over short distances by the flight of adult wasps, spread over long distances generally occurs by the movement of infested plants, twigs, or shoots. Early detection and destruction of infested plants outside infested areas remains the most effective method to avoid the spread of this insect. Thus, Ohioans are urged to report suspected infestations to the Ohio Department of Agriculture.

Oriental Beetle

Oriental beetle *(Anomala (= Exomala) orientalis)* has been existing in the extreme northeastern part of Ohio since the mid-1990s, but it has failed to move beyond that area of the state. However, in 2003, this scarab beetle was found in central Ohio, in the Columbus area.

Since this native of Japan was first discovered in Connecticut in the 1920s, it has moved into most of the New England states, as well as into New York, New Jersey, Pennsylvania, and the Carolinas. It was discovered causing damage to nursery stock in the mid-90s in Ohio.

Oriental beetle grubs produce plant injury that is very similar to damage caused by root weevil larvae, such as the larvae of black vine weevil *(Otiorhyncus sulcatus)*. The grubs consume roots and may occasionally girdle plants just below the soil level.

To distinguish between scarab beetle grubs and root weevil larvae, look for the legs. Scarab beetle grubs have legs, whereas weevil larvae are legless.

Both the oriental beetle and black vine weevil have similar life cycles. They both have one generation per year, and both insects overwinter as late-instar larvae. However, black vine weevil adults appear much earlier in the season than oriental beetle adults.

Oriental beetle grubs may also be confused with other scarab grubs found in the plant root zone, such as Japanese beetle *(Popillia japonica)* grubs. Japanese beetle grubs will feed and develop on decaying organic matter and typically injure roots through collateral damage. They are far less destructive to the roots of nursery stock.

White grubs are identified based on the shape of their anal slits and on patterns of bristles found on the underside of their posteriors. This area is called the raster.

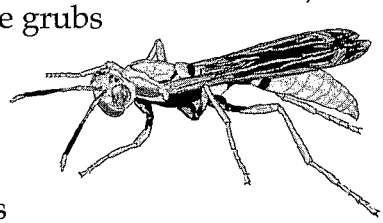
Japanese beetle grubs have a distinctive raster spine pattern that looks like a V. Oriental beetles have two parallel rows of small bristles, each row with about 14 spines. May-June beetle grubs have a similar raster pattern, but they also have a broad V-shaped anal opening, while oriental beetle grubs have an anal opening in the form of a transverse curve.

Oriental beetle adults are around 3/8" long, and they have varying color forms. Adults may be entirely brownish-black, or they may be black with patches of brown, or brown with patches of black. Usually the head is a solid dark brown, and the pronotum is dark in the center, and outlined in straw color.

The adults do little feeding, but they are occasionally found on flowers, particularly daisies. However, they cause little damage and are not considered the most damaging stage of this insect.

European Wasp

The European or dominulus wasp *(Polistes dominulus)* is an exotic, invasive species native to countries around the Mediterranean Sea. It was first discovered in Cambridge, Mass., during the late 1970s.



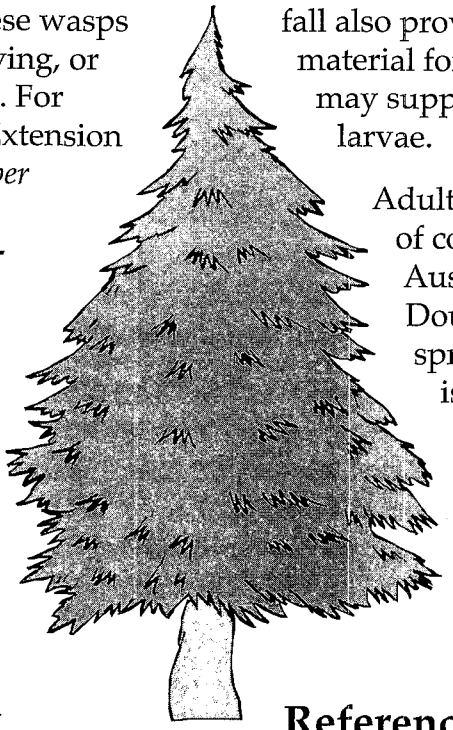
In the 30 some years the wasp has been in the United States, it has spread to Maine, Vermont, Connecticut, New York, New Jersey, Maryland, Pennsylvania, Ohio, Michigan, California, and Washington. It was first reported in Ohio in 1991. The European wasp also appears to be displacing the northern paper wasp *(Polistes fuscatus)*, a native species.

The wasp looks like a yellowjacket because of its yellow and black color patterns. The nest it constructs is the typical upside-down umbrella shape with open cells pointing downwards.

It is typically a cavity nester, but when a cavity is not found, it will use other protected sites such as under deck railings and roof eaves, but more importantly the European wasp has also been frequently observed nesting in dense trees and shrubs.

This nesting behavior increases the possibility of danger for landscapers, nurserymen, and homeowners encountering these wasps while working on or around ornamental trees and shrubs. During the 2003 season, nests of varying sizes with accompanying wasps were observed in several types of trees and shrubs including arborvitae, privet, Alberta spruce, and viburnum.

A chance encounter with these wasps while pruning, digging, moving, or planting could be disastrous. For control measures, see OSU Extension Fact Sheet HYG-2077-97, *Paper Wasps and Hornets,* at: **http://ohioline.osu.edu/hyg-fact/2000/2077.html.**



Pales Weevil

This past season, the C. Wayne Ellett Plant and Pest Diagnostic Clinic (CWEPPDC) at Ohio State received a sample of pales weevil *(Hylobius pales)* adult feeding damage on a white pine growing in a landscape far from any Christmas tree plantations. Adults feed by removing bark at the base of lateral shoots. Twigs on the sample had been completely girdled causing shoots to turn brown and die.

This weevil is usually considered a Christmas tree production pest since stumps left from the fall harvest of Christmas trees provide a bountiful supply of larval feeding material. Overwintered females are drawn by the odor of fresh pine resin oozing from the stumps, and they lay eggs on the bark. Once eggs hatch, the legless, grub-like larvae burrow into bark of the stump to feed on phloem tissue.

Larval development is completed during the summer, and new adults emerge by late summer to early fall. The new adults move to living trees to feed on stem tissue, causing shoots to turn brown, or "flag." They may also kill seedlings by feeding on the main stems.

So where did the weevils come from that caused damage to the white pine in a landscape? Conifers that have died in the fall also provide excellent larval feeding material for this weevil. A large tree may support hundreds of developing larvae.

Adults will feed on a wide range of conifers, including Scotch, Austrian, and white pine; Douglas-fir; true firs; and some spruces. Larval development is limited to pines and, occasionally, Douglas-fir. Dead pines should be removed from landscapes to avoid providing reproduction material for this weevil.

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Infectious Disease Problems of Ornamental Plants in Ohio: 2003

James A. Chatfield, Nancy A. Taylor, Erik A. Draper, David E. Dyke, Gary Y. Gao, and Joseph F. Boggs

Introduction

Disease summaries for 2003 were derived from Ohio State University Extension's *Buckeye Yard and Garden Line (BYGL)* electronic newsletter, reports from the C. Wayne Ellett Plant and Pest Diagnostic Clinic (CWEPPDC), and other reports.

As always, environmental conditions unique to the particular growing season played a big part in the profile of diseases for 2003. Spring and summer weather throughout Ohio was abnormally wet, which contributed to banner years for such foliar diseases such as apple scab, rose black spot, and anthracnoses on oak, planetrees, maple, and ash.

So let's take a look at a few of the disease profiles and disease-control perspectives from 2003. Let's also remind ourselves of the lighter and more philosophical aspects of horticulture by reviewing this past season's *BYGL*osophys at the end of this article.

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But before any of that, let's start with a brief reminder of what the philosopher Krishtalka meant when he opined:

"The beginning of wisdom is calling things by their right names."

A Fungus by Any Other Name

Communication is always a challenge in any job, and the green industry is no different. The old bugaboo of mistakenly thinking you understand what someone said is rife with trap after trap, even with something as simple as a name.

What's the trap in "What's in a name?" Let us begin to count the ways with a few of the items discussed in "Pest, Disease, and Weed Update" in an *American Nurseryman* magazine article by Jim Chatfield and Larry Steward.

"Fungi have both common and Latin names: Fungal plant pathogens, as well as bacteria and other plant pathogens (except for viruses) and all other organisms on earth are assigned Latin binomials. This two-part name, being the species, is composed of the genus and the specific epithet. Thus, the fungal pathogen for apple scab (with a common name of the apple scab fungus) is *Venturia inaequalis,* the rose powdery mildew fungus is *Sphaerotheca pannosa,* the fireblight bacterium is *Erwinia amylovora,* red maple is *Acer rubrum,* human beings are

Homo sapiens, and so forth. Scientists do not consider viruses to be truly living organisms so they are not given Latin binomials, and simply have names such as tobacco mosaic virus (TMV) and impatiens necrotic spot virus (INSV).

"Sometimes names change: Diplodia tip blight is a common disease of pines, especially Austrian and mugo pines, and several other conifers. Sphaeropsis tip blight is a common disease of pines, especially Austrian and mugo pines, and several other conifers.

What is the difference in the two diseases? None! Only the official name of the fungal pathogen for this disease has changed. For a variety of reasons, including the realization that the majority of spores of this fungus were not two-celled, the name of the pathogen was changed from *Diplodia pinea* to *Sphaeropsis sapinea.* The same disease, the same pathogen, but now with a new pathogen and disease name. Confusing though if you think someone is talking about a brand new disease.

"Sometimes fungal names are truly imperfect: Fungi are not the only organisms for which biologists change the two-part Latin binomial names. Fungi, though, are the only ones in which there is actually a classification called Fungi Imperfecti. This moniker came about because it has historically been very difficult to connect the sexual reproduction phase of a particular fungus with the asexual reproduction phase of that same fungus. These things happen when you're microscopic in size. This so frustrated the great Swedish classifier Linnaeus (who gave us the Latin binomial system) that he classified all fungi in one species back in the 1750s: *Chaos fungorum!*

"Imperfections continue, though, because with some fungi, the sexual stage was given one Latin name and the asexual stage another. Thus, the apple scab fungus has the name *Venturia inaequalis,* so named partly for the unequal size of the sexual (two mating types) spores produced in the previous season's scabby leaves in spring. But the asexual name *Spilocaea pomi* also represents the form of the fungus that occurs throughout the season without the benefit of two mating types coming together. This is confusing when you see it written differently or even both at once in different references. Such is life!"

Disease-Free Plants?

The term *disease-free* is often bandied about among gardeners, but is there really such a beast? In terms of a plant existing that cannot become diseased, the answer is No! All plants (or animals, or bacteria, or fungi, or any other organism for that matter) can become diseased.

Disease is a perfectly natural interaction between hosts and pathogens. We may not like that interaction, but nature, red in tooth and claw (and bacteria, fungi, and viruses), cares not for such sentiments.

Organisms can, however, have relative proneness to specific diseases. With humans and other animals, this involves an immune system and other defenses. Plants have no immune system but possess various ways to defend themselves — from single gene genetic resistance to pathogens, to hypersensitive

responses to infections, resulting in localized death of all plant cells, thus starving the pathogen and preventing spread; from physical features such as thick cuticles that help prevent infection to something we are learning more and more about called systemic acquired- and systemic-induced resistance.

In the everyday practice of horticulture, the term most used is *resistance* to plant disease. It is important to realize that the term resistance is a relative term, a sliding scale. So 'Prairifire' crabapple has excellent resistance to apple scab disease, but not immunity. 'Prairifire' will get apple scab if disease pressure is high (wet spring conditions), especially on lower leaves which stay wet longer. Note that this resistance is listed only for apple scab.

For example, 'Dolgo' crabapple has excellent apple scab resistance but has fairly high susceptibility (is less resistant) to frogeye leaf spot disease. 'Golden Raindrops' crabapple is highly resistant to scab disease, but relatively speaking, 'Golden Raindrops' is highly susceptible to fireblight disease.

So, take note of the specifics when you hear something touted as *disease-free,* or *disease-resistant.* It's all in the details.

This theory of relativity has another component, of course. Namely, that what is true in one part of the country, or in one environmental region, is not necessarily true in another.

This truth was driven home to Erik Draper and Jim Chatfield this past year when they were in Oregon and Idaho evaluating crabapples and scouting out new plots for the International Ornamental Crabapple Society (IOCS). As they reported in *BYGL,* western Oregon, west of the mountainous rain shadow, has cool, wet spring weather and thus lots of scab pressure but less natural fireblight pressure because of the coolness of the temperatures.

Western Idaho in the Moscow area of the University of Idaho presents a different profile. The spring conditions are both dry and cool — so neither fireblight nor scab is a big factor. That is precisely why the IOCS develops evaluation plots throughout the country.

A nurseryman who sells nationwide wants to know in which markets each crabapple taxon will thrive, both disease-wise and horticulture-wise. 'Royalty' and 'Golden Raindrops' will not do so well here, due to scab and fireblight pressures, respectively, but where there is no scab, 'Royalty' can be a good purple-leaved alternative. And 'Golden Raindrops,' while a problem in many years in Ohio due to fireblight, thrives where fireblight is not a factor. The trial plots highlight why.

Anthracnose Diseases of Shade Trees

Anthracnose diseases of a wide range of trees *(e.g.,* sycamore, oak, ash, and maple) were common this spring, especially with the cool, wet conditions during leaf emergence of many tree species. There were many reports of anthracnose on sycamore (and much more mildly on London plane), on ash, on oak (especially white oak), and on maple.

With all these anthracnose diseases, there is the blotchy leaf discoloration associated with the major veins of the plants, but sometimes this symptom is obscured by the more extensive blotching and wilting of leaves on oak and especially sycamore.

With early sycamore anthracnose infections, for example, sometimes the damage was so extensive that leaves simply shriveled up and twig dieback occurred, and there were hardly enough leaves to even look for the characteristic reddish-brown blotching along leaf veins.

Several later-season anthracnose diseases were also commonly noted this year, including hickory anthracnose, walnut anthracnose, and with a fine line of necrosis along main leaf veins, yellowwood anthracnose. Dogwood anthracnose on flowering dogwood caused significant damage to foliage and stems of dogwoods growing in densely shaded areas.

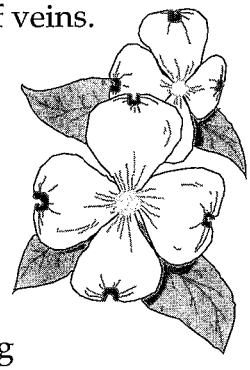
Phytophthora ramorum Survey

Enrico Bonello conducted a survey for *Phytophthora ramorum* in Ohio nurseries (15 counties) this summer. From more than 250 samples collected from foliar lesions and dying twigs of rhododendrons and azaleas, a *Phytophthora* sp. was isolated, but none were *Phytophthora ramorum*, the causal agent of sudden oak death and other diseases found in the Pacific Northwest in the past several years.

The usual *Phytophthora* pathogens of *Rhododendron* spp. were found, including isolates of *Phytophthora citricola, P. citrophthora, P. cactorum, P. nicotiana,* and others, but no *P. ramorum.*

Honeylocust Knot Update

This unusual disease was profiled in the 2002 ornamental circular, at which time it was reported that the causal agent of this disease was not yet known. Enrico Bonello's lab continued to work on this perplexing problem this year, and bacteria with potential pathogenicity were isolated. However, inoculations with these isolates did not reproduce the symptoms of honeylocust knot; therefore, to date, the pathogen for this disease is still unidentified.



Botryosphaeria Canker of Juniper

As if Phomopsis dieback, Kabatina dieback, and cedar rusts were not enough, Nancy Taylor cultured the *Botryosphaeria* fungus from elongate cankers on a Rocky Mountain juniper *(Juniperus scopulorum)* in the CWEPPDC the season. This disease is quite a problem on this species in Kansas and other central states but has not commonly been identified in Ohio.

Appropriately enough, the sample Nancy received was the cultivar 'Wichita Blue,' which is listed in publications as being particularly susceptible to the problem, apparently even when in Ohio and not in Kansas anymore.

Eastern Filbert Blight

This fungal disease, caused by *Anisogramma anomala,* can devastate a planting if left unchecked. The native hazelnut *(Corylus americana)* serves as a host for the disease organism but is somewhat tolerant to its attack. Hybrids between *C. americana* and *C. avellana* are somewhat tolerant to blight.

The fungus infects the bark, turning it dark. Twigs and branches become infected, and leaves wilt and collapse beyond the diseased portion. Eventually the fungus is characterized by rows of black pustules breaking through the bark.

Diseased portions of wood should be pruned out and burned. Fixed copper

sprays during the growing season may help control this disease. Susceptible specimens in the planting should be rogued out.

Dodder: An Infectious Plant

Dodder *(Cuscata* spp.) is one of the few plants that is considered a pathogen capable of causing infections of other plants (other examples include mistletoes and witchweed). Dodder is a flowering plant (tiny white flowers) but does not produce chlorophyll (though it does have chloroplasts) and gets its nutrition from plants it parasitizes by sending suckers down into the host-plant tissue.

*BYGL*ers receive a few calls each year about dodder causing a problem on vegetable gardens or landscape beds, typically with the caller describing a light-yellow wire-like thing all tangled up in plants. One case described this year was on coreopsis and butterfly bush. Dodder is often introduced into the garden or landscape through contaminated soil, tools, or clothing. Dodder reproduces mainly by seeds.

According the University of Minnesota Yard and Garden Brief H521D: "Dodder forms tiny flowers which may produce up to 3,000 seeds on a single plant. These seeds have a very hard seed coat which allows them to survive several years. So the results of one year's infestation can have long-term effects as these seeds germinate year after year."

Once dodder has been introduced, it is difficult to control. The best control is to remove all infested plants and dodder before the weed goes to seed. Be sure to dispose of all traces of dodder; this means cleaning your tools and clothes. It only takes a very small portion to begin a new plant.

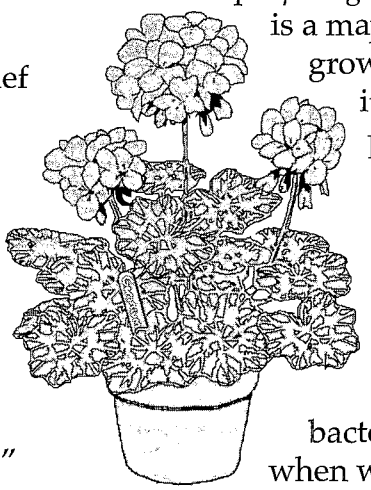
Repeated cultivation is also helpful as it allows more of the seed to germinate and be killed before going to seed. This decreases the number of seeds remaining in the soil.

A pre-emergent herbicide used after the desirable plants are established will have some effectiveness. It should prevent the dodder seeds from germinating without harming the plants they would latch on to.

Without a host, dodder seedlings will live for only a few weeks before they die. By planting species that are not susceptible to attack by dodder, such as grasses, dodder will eventually die. Any of the ornamental grasses would be a good choice to put into infested areas for a year or two.

Bacterial Blight of Geranium

A serious problem of florist's geranium *(Pelargonium* x *hortorum)* is bacterial blight caused by *Xanthomonas campestris* pv. *pelargonii.* This bacterial disease is a major problem for greenhouse growers, especially when it develops in cutting propagation. The disease is difficult to manage because cool temperatures mask disease symptoms.



Plants that seem healthy may later show symptoms when conditions favorable for the bacteria occur. This is a problem when wholesalers send plants on to growers who finish off the plants only to find, late in the production season, that plants are infected and wilt and collapse.

Symptoms include leaf spots and stem rots. Sometimes the disease does

not manifest symptoms until plants are subjected to stresses in landscape plantings.

For further information on bacterial blight of florist's geranium, please refer to *Leaf Spot and Stem Rot (Bacterial Blight) of Geranium (Pelargonium* spp.), PP-739 (Revised), North Dakota State University Extension Service, at:
http://www.ext.nodak.edu/extpubs/plantsci/landscap/pp739w.htm

Volutella Leaf Blight and Stem Canker of Pachysandra

This disease was predictably common this year, with our sustained wet weather. Symptoms include a zonate spotting on the foliage and blackened blighting of the stems.

If you want to check to see if observed stem discoloration and wilting on pachysandra are caused by Volutella fungus *(Volutella pachysandricola),* put some samples in a plastic bag and wait for a few days. Orangish-pink spore masses of the fungus develop in the cankered areas.

Fungicide applications can help if you make multiple applications during periods of active growth of the pachysandra (much of the growing season, unfortunately), but mowing the planting down to an inch or two, removing all diseased and mowed plant tissue, and avoiding overhead irrigation is often the more practical solution.

Of course, the overhead irrigation in a year like 2003 is the constant rain, and alas, there is no answer for that — other than the inevitable future droughts that will come soon enough.

Now — enough of disease! Let's look at some of the plant-itudes and tree-ism philosophizing from this past year's *BYGLs* and from other sources, starting with some seasonal notes.

*BYGL*osophys

Will it not be employment enough to watch the progress of the seasons?

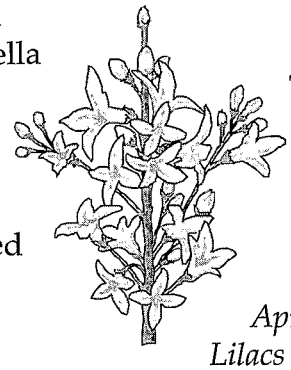
— Henry David Thoreau

The English winter — ending in July,
To commence in August.

— Lord Byron

Let us love winter, because it is the spring of genius.

— Pietro Aritino



The trumpet of a prophecy! O Wind,
If Winter comes, can Spring be far behind?

— Percy Bysshe Shelley

April is the cruelest month, breeding
Lilacs out of the dead land, mixing
Memory and desire, stirring
Dull roots with spring rain.

— T. S. Eliot

The fiddlehead ferns down by our pond
stand like the stems of violins
the worms are playing beneath the moss.

Last autumn's leaves are pierced by shoots
that turn from sickly-pale to green.
All growth's a slave, and rot is boss.

— John Updike

The melancholy days are come, the saddest of the year.
Of wailing winds, and naked woods,
and meadows brown and sere.

— William Cullen Bryant

Sing a song of seasons!
Something bright in all
Flowers in the Summer,
Fires in the Fall!

— Robert Louis Stevenson

No warmth, no cheerfulness, no healthful ease,
No comfortable feel in any member —
No shade, no shine, no butterflies, no bees,
No fruits, no flowers, no leaves, no birds, —
November!

— Thomas Hood

First the howling winds awoke us,
Then the rains came down to soak us.
Now before the mind can focus —
Crocus.

— Lilja Rogers

Live in each season as it passes; breathe the air, drink the drink, taste the fruit, and resign yourself to the influences of each...Some men think that they are not well in spring, or summer, or autumn, or winter; it is only because they are not well in them.

— Henry David Thoreau

All gardening is landscape painting.

— Alexander Pope

Flowers leave some of their fragrance in the hand that bestows them.

— Chinese proverb

Courage is not the towering oak that sees storms come and go; it is the fragile blossom that opens in the snow.

— Alice M. Swain

The whole of nature, as has been said, is a conjugation of the verb to eat, in the active and passive.

— William Ralph Inge

Sunshine is delicious, rain is refreshing, wind braces us up, snow is exhilarating; there is really no such thing as bad weather, only different kinds of good weather.

— John Ruskin

The good rain, like the bad preacher, does not know when to leave off.

— Ralph Waldo Emerson

A garden is never so good as it will be next year!

— Thomas Cooper

Among gardeners, enthusiasm and experience rarely exist in equal measures. The beginner dreams of home-grown bouquets and baskets of ripe fruit, the veteran of many seasons has learned to expect slugs, mildew, and frost.

— Roger Swain

If you are not killing plants, you are not really stretching yourself as a gardener.

— J. C. Raulston

Gardening requires lots of water — most of it in the form of perspiration.

— Lou Erickson

Training is everything. The peach was once a bitter almond; cauliflower is nothing but cabbage with a college education.

— Mark Twain

In order to live off a garden, you practically have to live in it.

— Frank McKinney Hubbard

Rest is not idleness, and to lie sometimes on the grass on a summer day listening to the murmur of water, or watching the clouds float across the sky, is hardly a waste of time.

— John Lubbock

I have often thought that if heaven had given me choice of my position and calling, it should have been on a rich spot of earth, well watered, and near a good market for the productions of the garden. No occupation is so delightful to me as the culture of the earth, and no culture comparable to that of the garden.

— Thomas Jefferson

There's one good thing about snow, it makes your lawn look as nice as your neighbor's.

— Clyde Moore

Perennials are the ones that grow like weeds, biennials are the ones that die this year instead of next, and hardy annuals are the ones that never come up at all.

— Katherine Whitehorn

No Spring nor Summer beauty hath such grace, As I have seen in one Autumnal face.

— John Donne

Tickle the earth with a hoe, it will laugh a harvest.

— Author Unknown

There are no gardening mistakes, only experiments.

— Janet Kilburn Phillips

A flower is a leaf mad with love.

— Goethe

The Amen! of nature is always a flower.

— Oliver Wendell Holmes Sr.

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Emerald Ash Borer: The Beginning of the End of Ash in North America?

Daniel A. Herms, Amy K. Stone, and James A. Chatfield

Introduction

Since its accidental importation from Asia, the emerald ash borer (*Agrilus planipennis*) has infested and killed more than six million ash trees (*Fraxinus* spp.) in southeastern Michigan woodlands, parks, urban forests, street-tree plantings, landscapes, and nurseries.

The core infestation of this exotic, invasive insect now extends across two to three thousand square miles in 13 counties in southeastern Michigan and Windsor, Ontario.

The threat cannot be over-estimated.

All major North American ash species have been killed by the emerald ash borer, which infests trees ranging in size from 1-1/2-inch-caliper nursery stock to fully mature trees in forests. While most native borers kill only severely weakened trees, the emerald ash borer kills healthy trees as well, making it especially devastating.

If it is not contained and eradicated, the impact of the emerald ash borer on ash in North America will be similar to that of chestnut blight and Dutch elm disease, which devastated woodland and urban forests in the 20th century.

The emerald ash borer was unknown in North America until June 2002, when it was discovered killing ash trees in southeastern Michigan and neighboring Windsor, Ontario. This borer is native to eastern Russia, northeastern China, Mongolia, Taiwan, Japan, and Korea, where it occurs on several species of ash. It was probably imported to Michigan by means of infested ash crating or pallets at least 10 years ago.

Localized infestations discovered in Ohio in 2003 in Lucas (February), Defiance (August), Paulding (August), Wood (September), and Franklin (November) counties have triggered ongoing eradication efforts in Ohio.

In September 2003, an infestation was also confirmed in Maryland near Washington, D.C. Artificial spread of the insect has been traced to movement of infested ash logs, firewood, and nursery stock.

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Economic and Ecological Impact of Emerald Ash Borer

The economic and ecological impacts of the emerald ash borer have already been substantial — and will be staggering if this exotic pest continues to spread. It clearly has the potential to reduce dramatically the importance of ash as a component of North American forests, which will have dramatic effects on forest ecosystem processes, as well as plant and animal communities.

Ash species, which inhabit a variety of soils and ecosystems, are dominant throughout the forests of eastern North America. An Ohio Department of Natural Resources study estimated that there are more than 3.8 billion ash trees in Ohio, with standing timber valued at more than $1 billion.

Furthermore, ash is one of the most important nursery and landscape species. According to the USDA, the wholesale value of ash sold by Ohio nurseries exceeded $20 million in 1998, a market threatened by the emerald ash borer.

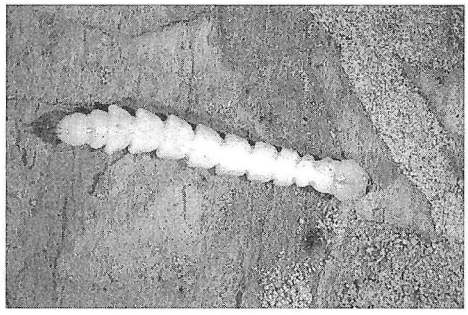
Michigan and Ohio have already experienced serious economic impacts. Ash has been one of the most commonly planted trees in landscapes and urban forests. In Michigan, the emerald ash borer has already caused an estimated $11.6 million of damage to landscapes and woodlots, and quarantines have restricted the sale of $2 million worth of nursery stock.

In addition, costs of removing dead and dying ash trees have overwhelmed municipal budgets in the affected counties, and private property owners must often pay in excess of $1,000 per tree for removal of large shade trees. A quarantine on ash timber also has had negative economic impacts on sawmills, tool handle factories, and firewood dealers in Michigan and Ohio.

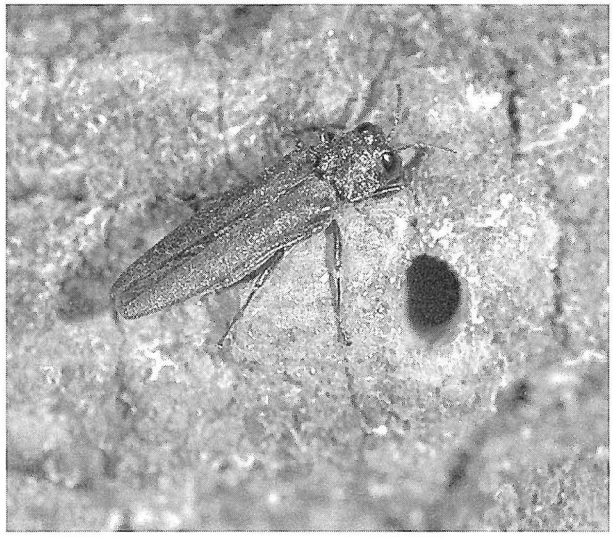
Eradication costs for the localized emerald ash borer infestation in Lucas County, Ohio, in April 2003 exceeded $300,000, while projected costs of eradication in southeastern Michigan are estimated at $350 million over the next 10 to 13 years.

Taxonomy and Biology

Taxonomically, the emerald ash borer is a beetle (Coleoptera) belonging to the family known as metallic wood-borers (Buprestidae). Adults of many species



Larvae of the Emerald Ash Borer



Adult Emerald Ash Borer
Note the D-shaped exit hole, a sure sign of infestation.

in this family are brightly colored with a metallic glint, making them favorites of collectors.

Larvae of these beetles are known as *flatheaded* borers, deriving this common name from the larvae which appear to have a broadly flattened head (it is actually the thorax which mostly conceals the much smaller head). Emerald ash borer larvae are white with a long (about one inch when mature) narrow, segmented abdomen that is also flattened, which gives them the appearance of small tapeworms. Adults are elongate, 1/2-inch-long beetles with striking metallic-green coloration.

The emerald ash borer belongs to the same genus (*Agrilus*) as bronze birch borer (*A. anxius*) and twolined chestnut borer (*A. bilineatus*), which are both native to North America. The biology of emerald ash borer is quite similar to its native relatives. There is one generation each year. Adults emerge from late May through early August, with emergence peaking in early July.

As adults emerge, they leave small (1/8 inch), distinctly D-shaped exit holes in the trunk and main branches, which are a sure sign of infestation. Adults feed on foliage for one to two weeks prior to mating.

Females produce 50 to 100 eggs, which are laid individually on the bark surface, or within bark cracks and crevices. Observations indicate that upper portions of the trunk are colonized initially, making it difficult to detect early infestations.

As larvae hatch, they tunnel into the tree, where they feed on the phloem and outer sapwood, excavating S-shaped, serpentine galleries just under the bark.

Larvae continue to feed through summer and into the fall, with most completing their development prior to over-wintering in the outer bark or just under the inner bark within the outer inch of sapwood. Pupation occurs in mid- to late spring. Adults emerge soon thereafter to complete the typical one-year cycle.

Diagnosing Emerald Ash Borer: Signs and Symptoms

Infestations of emerald ash borer are difficult to detect until they become severe. This is because larvae are hidden under bark; they colonize the upper portion of the trunk first; and symptoms resemble other causes of tree decline.

There are few external signs or symptoms of early infestations. When trees are still vigorous, small, vertical splits may form in the bark in response to the growth of wound-periderm (callus) tissue that forces out the bark as it forms over larval galleries in the phloem.

To confirm the presence of emerald ash borer, widen the splits to reveal larvae and galleries under the bark. Larval galleries are distinctly S-shaped or serpentine, and are packed tightly with frass, a mixture of sawdust and excrement. The galleries are also visible on the inner surface of the outer bark when removed.

The presence of small (1/8 inch) D-shaped exit holes in the trunk or main branches, caused by emerging adults, is a sure sign of infestation. As infestations progress into the second year, the canopy will start to thin, and branch dieback may occur. Decline accelerates rapidly, and trees are generally killed within two to four years of

infestation. Epicormic shoots often sprout from the main trunk of declining trees.

Woodpeckers are proving to be important predators of the emerald ash borer. A noticeable increase in woodpecker activity on ash trees can provide an early indication of an infestation, especially during winter.

Distinguishing Emerald Ash Borer From Native Borers

Green Industry professionals and Extension personnel called to inspect declining ash trees may have the first opportunity to detect new emerald ash borer infestations before they become well established. However, there are several native clearwing and roundheaded borers that also commonly infest ash. Hence, the ability to distinguish emerald ash borer infestations from those of native borers is extremely important.

Among the most common of the native ash borers are the banded ash clearwing borer (*Podosesia aureocincta*) and ash/lilac borer (*P. syringae*), both of which are the larvae of clearwing moths. The banded ash clearwing borer has become especially common in Ohio's urban forests.

The presence of D-shaped emergence holes in the trunk and main branches is the most distinctive diagnostic guide.

Although many signs and symptoms of native borers resemble those of emerald ash borer, there are several important characteristics that are useful in distinguishing clearwing borer infestations from those of emerald ash borer. In particular, the nature of the galleries and the shape of the exit holes are distinctly different.

Clearwing larvae bore deep into the sapwood, while galleries of emerald ash borer are confined to the phloem tissue just under the bark. Clearwing borers expel their frass from the tree, which can accumulate in large quantities in bark crevices, branch crotches, and on the ground, providing a good sign of an infestation. Conversely, emerald ash borer larvae pack their frass tightly within their galleries as they feed. Upon emerging, clearwing borers leave behind a pupal case, which is sometimes found protruding from the emergence hole. Flatheaded borers, on the other hand, do not produce a pupal case.

The shape of adult emergence holes in the trunk is the most distinctive diagnostic guide. The emergence holes of emerald ash borer are distinctly D-shaped, while emergence holes of clearwing borers of ash are larger (1/4-inch diameter) and round. Because the galleries of clearwing borers penetrate into the sapwood, one can insert a thin wire through the emergence hole well into the tree. This is not possible with emerald ash borer exit holes, as the galleries wind just under the bark and are plugged with frass.

There is a native species of *Agrilus* that infests ash, and it probably also produces D-shaped emergence holes. However, it is much smaller than emerald ash borer, and colonizes only small branches and twigs.

Several species of roundheaded borers also infest ash, with the redheaded ash borer (*Neoclytus acuminatus*) being the most common in Ohio. Roundheaded borers are larvae of longhorned beetles (Order: Coleoptera; Family: Cerambycidae), which derive their name from the very long antennae of adults. As their name implies, the larvae of redheaded ash borer

and other roundheaded borers are round in cross section, in contrast to the highly flattened profile of flatheaded borers.

Redheaded ash borer infestations can also be distinguished from emerald ash borer by the presence of large (3/8-inch wide), oval exit holes. Galleries initially form just under the bark and are packed with frass, as is the case with emerald ash borer. However, redheaded ash borer galleries are not nearly as serpentine.

As larvae mature, they extend their galleries well into the sapwood, usually following the grain of the wood, while emerald ash borer galleries are restricted to the phloem. Furthermore, redheaded ash borer is restricted to severely weakened, dying, and freshly killed trees *(e.g.,* freshly cut timber and firewood), while emerald ash borers colonize even healthy trees.

In summary, the presence of serpentine galleries packed tightly with frass just under the outer bark, coupled with D-shaped emergence holes in the trunk and main branches, are the tell-tale signs of an emerald ash borer infestation.

Host Plants and Host Impact

Ash species known to be infested in Michigan include green ash (*Fraxinus pennsylvanica*), white ash (*F. americana*), black ash (*F. nigra*), and blue ash (*F. quadrangulata*), as well as horticultural cultivars of these species. Only living trees are colonized. The emerald ash borer will not colonize a dead tree. Native host plants in Asia also include ash species, with *F. mandshurica* (Manchurian ash) and *F. chinensis* being primary hosts.

In China, the emerald ash borer is known only to colonize ash. In Japan, species of *Juglans* (walnuts and bitternuts), *Ulmus* (elms), and *Pterocarya* (wingnuts) have also been recorded as hosts. However, the emerald ash borer has not been well studied in Japan.

Furthermore, host records for borers are notoriously unreliable. For example, host records for wood-borers often include species from which adults were collected, even when they do not colonize that species in the larval stage. Research this past year at Michigan State University strongly suggests that walnut and elm are not viable hosts for emerald ash borer larvae.

Adult beetles feed on foliage, resulting in irregular, jagged-edged patches of missing tissue along the leaf margin, the impact of which is negligible. The larva is the damaging stage, girdling the tree as it tunnels under the bark where it feeds primarily on phloem tissue. This disrupts the flow of carbohydrates between the canopy and the roots, which results in canopy thinning, branch dieback, and finally tree death, typically within two to four years of initial infestation.

Larvae also engrave the outer layers of the water-conducting sapwood (xylem) as they feed. This type of feeding by *Agrilus* spp. actually causes relatively little harm to trees such as birches with a xylem anatomy known as *diffuse porous,* because water is conducted through a number of annual growth rings, most of which are not injured. Rather, flatheaded borers, such as bronze birch borer (*A. anxius*), tend to kill diffuse porous species gradually as girdling of phloem starves the roots.

On the other hand, *ring porous* trees, such as ash, can be killed rapidly by flatheaded borers, such as the emerald ash borer (*A. planipennis).* The functional xylem of ring porous trees is confined to the current growth increment just under

the bark. Borers, such as the emerald ash borer that scar the surface of the xylem, cause extensive damage to this very thin layer of water-conducting tissue as they engrave the surface of the sapwood. This disrupts the transpiration stream, which can result in rapid decline and death of infested trees, especially during periods of drought.

Ohio State University's Research on Host Plant Resistance

In Asia, the emerald ash borer does not devastate its native hosts. Reports indicate that outbreaks are isolated and associated with stress events such as drought. This suggests that in Asia, native ashes may be generally resistant, and that the emerald ash borer preferentially colonizes stressed trees.

Thus, the emerald ash borer behaves in Asia much as its close native relatives do in North America, including the bronze birch borer and the twolined chestnut borer, which also preferentially colonize stressed trees.

Native trees may be more resistant to their native pests because of natural defenses that have evolved over eons. Hence, Asian ash trees may be a source of resistance genes.

Researchers at Ohio State University — Daniel Herms, Entomology, and Enrico Bonello, Plant Pathology — are collaborating with colleagues at Michigan State University to investigate this possibility. An experimental ash planting was established in 2003 in Novi, Michigan (with trees donated by Bailey Nurseries, Inc.), to compare resistance of native and Asian ashes to the emerald ash borer, identify mechanisms of resistance, and determine the effects of drought and other stressors on borer susceptibility.

The planting includes white ash, green ash, Manchurian ash (with which the emerald ash borer shares an evolutionary history in Asia), and Northern Treasure ash (*F.* x Northern Treasure), which is a hybrid between native black ash and Manchurian ash.

Our working hypothesis is that the Asian ash will prove to be most resistant because of natural defenses resulting from coevolution with the insect. The inclusion of the native-Asian hybrid may provide insight into patterns of inheritance of resistance genes and facilitate their identification.

Identification of resistant genotypes will be critical for reforestation.

Identification of resistant genotypes will be critical for reforestation, as well as maintaining market demand for ash in the nursery industry. Identification of resistance mechanisms and their relationship to whole-tree physiology will facilitate screening, selection, and/or breeding of resistant trees, as well as cultural management of the emerald ash borer in urban and natural forests.

The Plan to Eradicate the Emerald Ash Borer

USDA-APHIS (Animal and Plant Health Inspection Service) and its Canadian counterparts, in cooperation with Departments of Agriculture in infested states, are in the early stages of implementing a program to eradicate emerald ash borer from North America. The plan in the core infestation area of southeastern Michigan, where millions of trees are already infested, is to first contain the pest, then reduce beetle density, and finally eradicate the insect.

There are so many infested trees in the core infestation zone in southeastern Michigan that it will be physically impossible to remove them all before insects can emerge. Rather, the core infestation is being managed following strategies similar to those used to manage large forest fires. A *firebreak* will be created around the core to contain the infestation. Once contained within the firebreak, the infestation should extinguish itself by killing all of its host trees, thereby starving itself out of existence.

The plan is for the firebreak to be wide enough to prevent the emerald ash borer from crossing it in search of new hosts, at least in large numbers. The firebreak will be constructed by removing ash trees in a zone around the periphery of the infestation, a task that will be facilitated by routing it through areas with naturally low densities of ash such as agricultural land, industrialized areas, and large bodies of water. Surveys and research are ongoing to determine just where the firebreak should be located, and how wide it should be.

Rapid elimination of outlier infestations is critical.

An aggressive emerald ash borer suppression program will occur just inside the firebreak to relieve pressure on the containment zone and minimize emerald ash borer breakouts. An intensive monitoring program around the periphery of the firebreak is designed to detect any spot infestations caused by *sparks* that jump the firebreak, which will be quickly extinguished.

Preventing the artificial spread of the emerald ash borer to new areas is another major component of the eradication plan. Accordingly, quarantines have been enacted in Michigan and Ohio to prohibit movement of ash trees, logs, branches, firewood, and untreated lumber. Currently, quarantines in Ohio are very isolated, impacting areas only in the immediate vicinity of some known infestations, but they are subject to change as the status of emerald ash borer infestations change.

Questions about the current status of quarantines in Ohio should be directed to the Ohio Department of Agriculture, Plant Pest Control. The Ohio Department of Agriculture is also conducting systematic surveys throughout Ohio in order to rapidly detect any additional outlier infestations that may occur in the state.

Rapid elimination of these outlier infestations is also a critical aspect of the eradication plan. Isolated infestations that flare up when *sparks* jump the firebreak will be quickly extinguished before they can become well established. This is the situation in Ohio, where a small infestation was detected in Lucas County in February 2003. In response to this discovery, the Ohio Department of Agriculture, in accordance with its responsibility under the Ohio Revised Code to protect Ohio's plant industries from exotic pests, immediately initiated an eradication program that was completed by the end April, before any adult beetles could emerge and spread the infestation.

The Lucas County eradication program entailed removal and destruction of more than 8,000 ash trees in a quarter-mile radius surrounding the known infestation. Since infested trees do not show external signs or symptoms of attack during the first year, there is no way to determine which trees in the vicinity of infested trees were themselves infested. However, the presence of D-shaped emergence holes on the obviously infested trees was evidence

that females had emerged to lay eggs on other trees, making the existence of asymptomatic carriers a certainty.

Consequently, it was necessary to cut even apparently healthy trees to destroy the insects lurking within before they could emerge to infest even more trees. Bark removed from some of these asymptomatic trees confirmed that they were in fact infested. To destroy the insects, felled trees were chipped and then incinerated at a co-generation power plant.

The assumption behind this strategy was that a cutting zone with a quarter-mile radius was sufficient to destroy the entire emerald ash borer population, including insects in trees that had yet to show symptoms of infestation. However, in the event that some emerald ash borer adults had dispersed beyond one-fourth mile, all ash trees just outside the cutting zone were treated preventively with the systemic insecticide imidacloprid in April 2003.

This treatment zone extended from the edge of the cutting zone out to one-half mile from visibly infested trees. The strategy behind the insecticide treatment was that any adults that escaped the cutting program would lay their eggs in the adjacent zone of treated trees, where their offspring would be killed.

Treating already infested trees with insecticides as an alternative to destroying them was not a viable option, as it would not have prevented adults from emerging and spreading to other trees. Insecticides are effective against borers only when applied preventively, in advance of infestations, and have no impact on borers already in the tree. This is true even of the systemically applied imidacloprid, which requires six to eight weeks for uptake and distribution.

Thus, imidacloprid must be applied in early to mid-spring to impact newly hatched larvae in July. By late summer, many larvae have matured, ceased feeding, and moved to over-wintering sites in the outer bark, where they would not be exposed to insecticide. Furthermore, larval feeding injures the xylem and phloem, which disrupts uptake and distribution of systemic insecticides by infested trees.

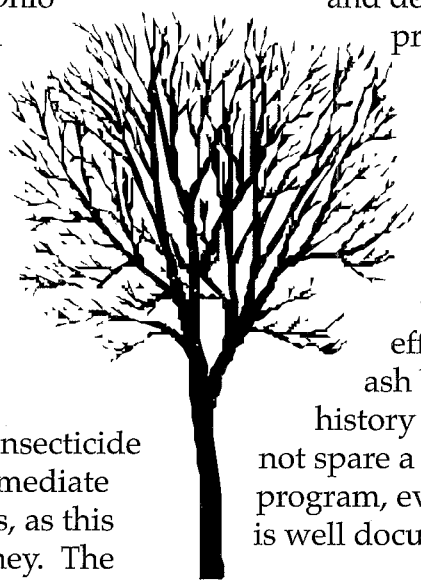
Should I Treat My Tree for Emerald Ash Borer?

Ohio State Extension personnel have received many questions from homeowners and Green Industry professionals wondering if preventive insecticide applications are necessary in Ohio to protect ash trees from the emerald ash borer. Members of the OSU Extension Nursery, Landscape, and Turf Team, in consultation with Ohio Department of Agriculture officials, have developed the following recommendation:

Currently, we do not recommend that any ash trees in Ohio be treated with insecticides for emerald ash borer, even if the tree is in the immediate vicinity of a known infestation.

First, it is important to maintain perspective on the problem. Although infestations in Ohio have received a great deal of attention, the fact remains that

in the entire state only a handful of trees are infested. The known infestations are all very small and very isolated, and the vast majority of ash trees in Ohio are not currently at risk, even in counties with known infestations. We've received reports of aggressive marketing of emerald ash borer insecticide treatments, but given the current status of the infestation, these programs are not warranted and cannot be justified.



We do not even recommend insecticide treatments for trees in the immediate vicinity of known infestations, as this also would be a waste of money. The logic behind this recommendation, which may seem counter-intuitive, is based on the interaction between the biology of the insect and regulatory issues associated with the program to eradicate the emerald ash borer from North America. The situation is different within the core infestation in quarantined counties in Michigan (for reasons discussed later), where many property owners are choosing to protect their trees with insecticides.

The emerald ash borer is an exotic insect that is currently regulated by USDA-APHIS, and is subject to eradication. Hence, if an infested tree is discovered in Ohio, it will have to be removed and destroyed.

Female emerald ash borers are highly mobile and lay eggs on many trees. Infested trees do not show any external symptoms during the first year of the infestation. Therefore, in the vicinity of any tree showing visible signs of infestation, there will be many more trees that are infested but with no external symptoms (asymptomatic carriers).

Since there is no way to tell if these trees are infested, all trees in the vicinity of the infested tree will have to be removed and destroyed, as per eradication protocols, before larvae mature and adults can emerge, even if the trees appear healthy. This will be true even if that tree has been treated previously with insecticide, as research has shown that no insecticide is 100% effective against the emerald ash borer. Therefore, a previous history of insecticide treatment will not spare a tree from the eradication program, even if that treatment history is well documented.

But What About Trees in the Immediate Vicinity of Known Infestations?

As of December 2003, very small, isolated infestations have been discovered in Ohio in Lucas, Defiance, Franklin, Paulding, and Wood Counties, and programs already have or soon will be implemented by the Ohio Department of Agriculture to eradicate these infestations.

If the eradication programs are successful, it will not be necessary to treat nearby trees with insecticides. People near an eradication zone may be tempted to treat their trees as insurance in case an emerald ash borer escapes the eradication program.

However, if a borer does escape, it is extremely unlikely that it will lay eggs only on trees that have been treated with insecticides, as the emerald ash borer lays many eggs as it moves from tree to tree.

If an emerald ash borer does lay eggs even on one untreated tree in the same neighborhood as the treated tree (for example, on wild trees along a fence

row, ditch, or in a woodlot), eventually the untreated tree will show signs or symptoms of infestation and will have to be destroyed. In this case, all trees in the vicinity of the infested tree will also have to be destroyed, even if they have been previously treated.

In the core infestation in southeastern Michigan, the situation is different. Because there are too many infested trees to cut down as part of the eradication program (discussed previously) and because property owners there are financially responsible for removal of dead trees on their property, many people in the core infestation zone are taking steps to protect their ash trees, including preventive insecticide applications.

In Closing

Emerald ash borer has the potential to decimate ash throughout their range in North America, and efforts to eradicate this invasive pest are now underway. Eradication is possible, but if these efforts are not successful, emerald ash borer will have devastating economic and ecological impacts in natural and urban forests.

The threat cannot be over-estimated

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Emerald Ash Borer Diagnostic Check-Off List

Joseph F. Boggs, Daniel A. Herms, and Amy K. Stone

A list of signs and symptoms that will be helpful in diagnosing an emerald ash borer infestation is presented here.

Emerald ash borers are a non-native insect, recently introduced to the United States. It is important to keep in mind that native ash borers are extremely common throughout the state, and the vast majority of borer-infested ash trees in Ohio are infested with native borers.

Thus far, the very few emerald ash borer infestations found in Ohio are extremely small and very localized, infesting only a handful of trees.

Check List

Diagnostic Signs and Symptoms Specific to Emerald Ash Borer

✓ Serpentine, S-shaped galleries tunneled just beneath the bark.

The galleries are etched into the underside of the bark and the outer sapwood.

Galleries are tightly packed with fine sawdust-like frass. They do not extend into the sapwood, as do those produced by the common native clearwing or roundheaded borers that infest ash.

✓ D-shaped emergence holes, one-eighth inch in diameter, through the bark.

This symptom is very clear — emerald ash borer exit holes are very distinct. If there is any doubt as to whether the holes are D-shaped, then it is not emerald ash borer.

Exit holes of native borers are either round or oval, and much larger in diameter (one-quarter inch or greater).

✓ Legless, flattened, heavily segmented, white to cream-colored larvae (1 inch in length when mature) found beneath the bark of living trees.

Each larval segment is almost bell-shaped. The long narrow shape, flattened appearance, and distinct segmentation cause the larvae to resemble small tapeworms.

Diagnostic Signs and Symptoms Consistent With Emerald Ash Borer, But Could Also Be Associated With Other Ash Problems

✓ Thinning canopy, top dieback, leading to the death of the tree within two to three years.

✓ Thin, relatively short (2 to 5 inches long) vertical splits through the bark of living trees.

Joseph F. Boggs, Ohio State University Extension, Hamilton County/South District; Daniel A. Herms, Department of Entomology, The Ohio State University/Ohio Agricultural Research and Development Center, Wooster; Amy K. Stone, Ohio State University Extension, Lucas County

- ✓ Unnatural epicormic shoots sprouting from the main trunk and/or from the base of the tree.
- ✓ Unusually heavy woodpecker activity on living trees, particularly in the winter.

Reporting Suspected Emerald Ash Borer Infestations

The Ohio Department of Agriculture (ODA) should be notified if the diagnostic check-off list provides strong evidence that an emerald ash borer infestation has been found. Strong support for an emerald ash borer diagnosis means that signs and symptoms specific to emerald ash borer were observed, including D-shaped emergence holes and serpentine galleries under the bark.

An emerald ash borer diagnosis is not supported if the only signs and symptoms observed are those that can also be associated with other ash problems.

Contact Information for the ODA

Special Emerald Ash Borer Hotline:

1-888-OhioEAB (1-888-644-6322)

Mailing Address

Ohio Department of Agriculture
Plant Pest Control Section
Attn.: EAB
8995 East Main Street
Reynoldsburg, OH 43068

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The Magnolia Scale: Biology and Management of a Key Pest of Magnolia

Daniel A. Herms and David G. Nielsen

Introduction

Scales are among the most devastating and difficult to control of all insect pests, and magnolia scale (*Neolecanium cornuparvum*) is no exception. Native to the eastern United States where it is widely distributed, magnolia scale is prone to sudden and dramatic outbreaks that can quickly overwhelm, weaken, and even kill susceptible plants.

The most important hosts of magnolia scale are star magnolia (*Magnolia stelleta*), lily magnolia (*M. liliiflora*), and their hybrids. Saucer magnolia (*Magnolia* x *soulangiana*) can also be severely infested.

Magnolias native to the United States are much more resistant, perhaps because they have developed natural defenses by virtue of their shared evolutionary history. Cucumbertree magnolia (*M. acuminata*) and southern magnolia (*M. grandiflora*) can be infested but are rarely damaged, while sweetbay magnolia (*M. virginiana*), bigleaf magnolia (*M. macrophylla*), and umbrella magnolia (*M. tripetala*) are rarely colonized.

Daniel A. Herms and David G. Nielsen, Department of Entomology, The Ohio State University/Ohio Agricultural Research and Development Center, Wooster.

Life History

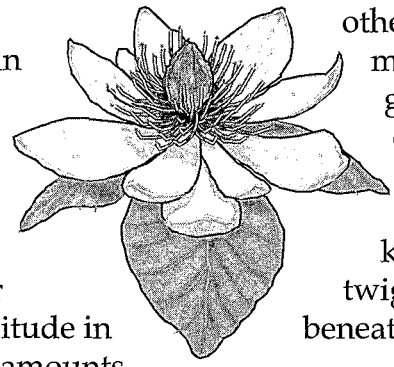
Magnolia scale has one generation per year, with females maturing and producing eggs from mid-summer through mid-fall. Eggs are held internally, creating the illusion that they give birth to living young. As with many species of scales, these newly hatched nymphs (first instars) are the only mobile life stage and are thus termed "crawlers."

In Wooster, Ohio, crawler emergence begins in early August (about 2050 degree-days, base temperature of 50°F) and continues well into October. Crawlers are very difficult to detect, appearing on small twigs and branches as very small (1/25 inch in length), flattened, oval flakes that vary in color from yellow to reddish-brown.

Upon emergence, crawlers set out in search of a suitable feeding site, often settling to feed on the same twig or branch as their mother. They become immobile once they insert their mouthparts into the plant, spending their entire life at the spot they initiate feeding.

The vast majority of crawlers are unable to establish for various reasons and die without ever feeding. As adult females are immobile, infestations probably spread most often when crawlers are carried on the feet of birds from one plant to another.

After overwintering as first instars, nymphs molt and begin growing about the time leaves begin emerging in spring (when large quantities of nutrients are mobilized by the plant in the sap). Growth is rapid as scales increase their size by several orders of magnitude in just a few weeks, and copious amounts of honeydew are produced during this growth spurt. Magnolia scale has become quite conspicuous (for a scale insect) as they mature, appearing as large, oval, convex bumps on twigs and branches. Twigs can be completely encrusted when populations are high.



As they mature, scales can vary in color from pinkish to purplish to brown, depending on the degree to which they are covered with a white, waxy material that disappears as eggs are produced by mature females, which are brown. Males mature earlier than females and do not grow as large. They emerge as small gnat-like insects in late spring to mate with immature females.

Females continue to grow through the summer, maturing in August – October. Adult females can obtain a diameter of one-half inch, making it the largest species of scale occurring in the United States. The adult females die in the fall after reproducing, leaving behind their hollow, brown shell (exoskeleton) that may continue to adhere to the plant for many months.

Host Impact

Magnolia scale feeds on sap extracted from twigs and small branches by means of sucking mouthparts inserted through the bark into the phloem tissue. Plant sap contains high concentrations of sugars but low concentrations of protein and other nutrients. Consequently, magnolia scales must extract great quantities of sap to obtain the nutrition they need. Much of this sap is excreted as a clear, sticky substance known as *honeydew* that coats twigs, leaves, and other objects beneath feeding sites.

The black fungus commonly known as *sooty mold* that often colonizes honeydew can be quite unsightly, but is generally harmless to plants (although, in extreme cases, it can interfere with photosynthesis by blocking light). Sooty mold can become a nuisance when it coats cars and patio furniture, and this mold is often the first sign of the infestation that people notice. Yellow jackets, other wasps, and ants are often attracted to the honeydew, upon which they feed.

The large quantity of energy-rich sap consumed by high populations of magnolia scale represents a severe energy drain on even mature plants. Stress imposed by this energy drain can result in small yellowing leaves, twig dieback, and a thinning canopy. When left unchecked, even mature plants can be killed by high populations. Generally, though, plants can tolerate low to moderate infestations fairly well, which provides time to implement a management program before plants are severely injured.

Management

As with all insect pests, effective management of magnolia scale requires a good monitoring program so infestations are detected before they build to damaging numbers. Plants should be regularly inspected for signs and symptoms of infestations. The absence of foliage makes winter a good time to observe the large brown shells on twigs

and branches that are the remnants of the previous generation of adults. Close inspection is required to observe the small overwintering nymphs, and a good hand lens can be a great help.

Magnolia scale nymphs grow rapidly in spring, becoming much more obvious. The presence of sticky honey dew on and beneath plants is a good sign of the existence of an infestation. Low populations are often clustered on one or a few branches that can be pruned without distorting the growth habit of the plant.

Natural enemies do not seem to effectively suppress high populations of magnolia scales, which is unusual for a native insect pest, making insecticide treatments necessary to maintain plant health. As with all scales, timing is critical. Their waxy covering and exoskeleton provides them with substantial protection, rendering conventional insecticides and horticultural oils ineffective during much of the growing season.

The crawler stage is quite susceptible to many insecticides, but the protracted period of crawler emergence dictates multiple applications from late summer through mid-fall. Biorational products, such as insecticidal soap and horticultural oil, can be very effective provided thorough coverage is obtained.

However, because these products lack residual activity, applications must be repeated every seven to 10 days throughout the eight- to 10-week period of crawler emergence in order to be effective. Insecticides with longer residual activity, such as synthetic pyrethroids, require fewer applications.

In theory, at least, it may be possible to achieve effective control with one optimally timed application in October just as crawlers have completed but before they enter dormancy, which probably reduces their susceptibility to insecticides. This window of opportunity is probably short, but research is still required to determine optimal timing.

No matter what product is used, thorough coverage of all twigs and small branches is essential, as many crawlers settle in protected areas such as bark crevices or under the shells of dead scales.

A more practical option may be a dormant application of horticultural spray oil targeted at overwintering nymphs in the spring before budbreak, a strategy that has proven effective for related species. A single application should be very effective if coverage is thorough. Applications can be made in late winter or early spring as long as the temperature is above freezing at the time of application.

Research Results with Imidacloprid

Recent research results show that soil drenches with the systemic insecticide formulations containing imidacloprid provide a simple and effective approach for managing magnolia scale. In a 2003 study, we found that soil drenches of Merit 75WP and Bayer Advanced Tree and Shrub Insect Killer applied on May 1 provided outstanding control of magnolia scale on plants that were heavily infested when treatments were applied (Table 1). Dead second instars also were observed on treated plants, indicating that treatments had an impact soon after they were applied.

By the end of the growing season, untreated plants were characterized by sparse canopies with small chlorotic leaves covered with copious amounts of honeydew produced by actively feeding females, which were fully mature with

Table 1. Efficacy of Imidacloprid Soil Drenches for Control of Magnolia Scale.		
Treatment	**Rate**	**Scale Numbers 16 DAT**
Untreated Control	NA	114.2 a
Merit 75WP	0.033 oz/ft	1.8 b
Merit 75WP	0.066 oz/ft	5.0 b
Bayer Advanced Tree and Shrub Insect Killer	1 oz/ft	4.0 b
Drenches were applied on May 1, 2003, and evaluated on August 12, 2003. Rates are expressed as amount of insecticide per foot of shrub height. Means followed by different letters are significantly different ($P < 0.05$).		

eggs. Conversely, treated plants were characterized by full, dense canopies with no honeydew present. Fall soil drench treatments were applied in October 2003 and will be evaluated during the summer of 2004.

Imidacloprid soil drenches should be applied around the base of the trunk (within 6 to 12 inches where high concentrations of fine roots facilitate uptake) using a bucket or watering can. Any mulch that may be present was pulled back first to facilitate infiltration. A small earthen dike can prevent run off from sloped surfaces and concentrate infiltration near the trunk. The amount to apply is based either on plant height (for shrubs) or trunk diameter (for trees). Imidacloprid has very low vertebrate toxicity, however (as with any insecticide), the safety precautions and usage rates outlined on the label must be followed.

In Summary

Magnolia scale can have a devastating impact on susceptible species. Successful management of this pest can be challenging, but it is possible. The key is a vigilant monitoring program coupled with judicious use of insecticides when necessary.

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Determination of Water Quality, Water Use Efficiency, and Water Runoff in Pot-in-Pot Nurseries

Charles R. Krause, Heping Zhu, Randall Zondag, Martin Shipitalo, Keith A. Williams, Ross D. Brazee, Richard C. Derksen, Michael E. Reding, Tom Demaline

Introduction

In nursery production, the application of pot-in-pot systems has expanded rapidly during the last decade. Using the pot-in-pot system offers several advantages:

- Can moderate root temperature.
- Improves root quality.
- Protects trees from root-killing heat on container side walls.
- Prevents extreme temperature changes during the winter.
- Can help prevent the blowing over of container-grown trees from the wind.
- Can reduce intensive harvesting labor costs compared to field-grown tree production.

The disadvantage of the pot-in-pot system is that it restricts root spread for extraction of nutrients and water. To compensate for the disadvantage, it is essential to apply supplemental fertilization to satisfy nutrient requirements and sufficient water two or more times throughout a day to sustain rapid growth of trees (Beeson and Gilman, 1995; Ruter, 1997). However, due to these irrigation and fertilization practices, there have been concerns about water-use efficiency and the extent of nutrient and chemical leaching from irrigation and rainfall to the soil and ground water.

To fully explore potential impacts of the pot-in-pot production system on nursery production, knowledge of water quality and quantity to produce healthy trees is needed to improve application efficiency and reduce the potential of soil and groundwater contamination. For this purpose, we established a research project in cooperation with Willoway Nurseries, Inc., at Avon, Ohio, to:

- Determine the amount of leachate in pot-in-pot nurseries due to different levels of spray tube irrigation and rainfall.
- Determine levels of nutrient and pesticide residues in leachate with various irrigation schedules and pesticide spray application methods.
- Determine the relationship between the amount of irrigation and soil moisture

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content in individual pots before and after leaching of water.

- Determine the relationship among soil moisture content, soil temperature, and tree growth rate.

Materials and Methods

An experimental system (Figure 1) to examine water quality, irrigation efficiency, and water runoff was established in a plot in Willoway Nurseries, Inc., in 2003. The system mainly consisted of a plot containing 50 trees planted in 50 pot-in-pot containers and irrigated with micro-spray emitters, 10 water runoff collection devices, 10 soil-moisture sensors, 10 thermocouples, a weather station, and a data logger.

Factors examined in this study were total amounts of irrigation, rainfall, and leachate from the plot; start and stop times for leaching; types of trees; soil-moisture content; soil temperature; and chemical residue levels, precipitation, and other weather conditions.

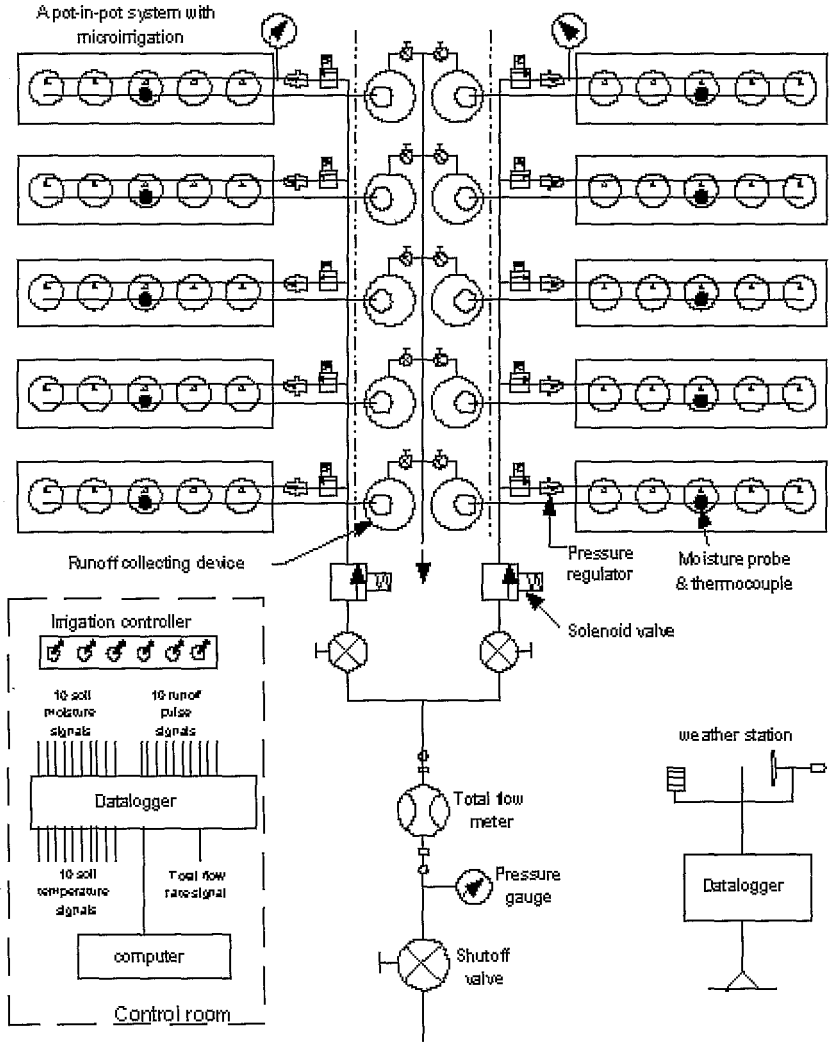

Figure 1. The experimental plot established to determine water quality and quantity for pot-in-pot nurseries

Pot-in-Pot Production Plot

The pot-in-pot production plot was divided into two separate zones (Figure 1). Each zone had five beds, and each bed had five pots of trees in containers. Spacing between each two beds was 1 m, and spacing between each two trees was 1.5 m.

A production container for trees had 15-gallon capacity and was placed in a socket container. The socket container was installed in the ground to the rim of the container. The Red Sunset maple (*Acer rubrum* 'Franksred') was selected for the test. The average tree caliper was 1.4 cm (0.55 inches) when installed on July 3, 2003.

The plot was irrigated with Netafim micro-spray emitters. Each pot had one emitter installed near the container side wall to ensure that all of the water applied spread evenly within the container. Each bed had an irrigation supplying line with a 7 kPa pressure regulator to minimize variations in application rate.

A solenoid valve was also installed before the regulator at the beginning of the irrigation line to control the irrigation schedule for each bed. A manual gate valve and a solenoid valve were installed in the water supply line to each zone. A Fluidyne Model 1200 inline vortex flow rate meter was used to measure the total flow rate and the total amount of water applied to trees in two zones. Irrigation management was controlled with micro-switches in a control room (Figure 1).

Water Runoff Measurement

A Spectrum Technologies Model 3665R "tipping bucket" rain gauge was installed 0.43 m below the soil surface (Figure 2) to measure the amount of water runoff from five tree containers in each bed. A total of 10 rain gauges was used for 50 container trees in 10 beds. The gauges were calibrated with both tap water and leaching water collected from the runoff.

The rain gauge was used because the amount of water runoff from five containers was very low, and there were no inexpensive electronic flow meters available for such a dripping measurement. A 5 cm (2-inch) PVC pipe was installed 7 cm under five containers in each bed and extended to a 0.6 m diameter and 1.2 m deep sump. The PVC pipe was connected to the socket container with a grommet and a street tee (Figure 2).

Once the rain gauge collected 7.5 ml of water leached from the five containers, it would produce a pulse signal to the data logger. The data logger tracked the real time when it received the pulse signals from the rain gauge. A manual shutoff valve was installed under the sump to drain the leached water to an adjacent pond. A water sample in each sump was collected every week for water quality analysis by USDA-ARS North Appalachian Experimental Watershed Lab in Coshocton, Ohio.

Soil Moisture and Temperature Measurement

The potting soil moisture was measured with 10 Theta Probe type ML2X soil-moisture sensors. Each bed had one sensor installed 5 cm below the soil surface in the middle container. The sensors were placed 45° in the potting soil and 5 cm from trees. The sensors were calibrated with the tree mix potting soil and the water containing 200 ppm of nitrogen at the moisture content ranging from 5% to 60%. Soil temperatures adjacent to moisture probes were also measured with 10 thermocouples.

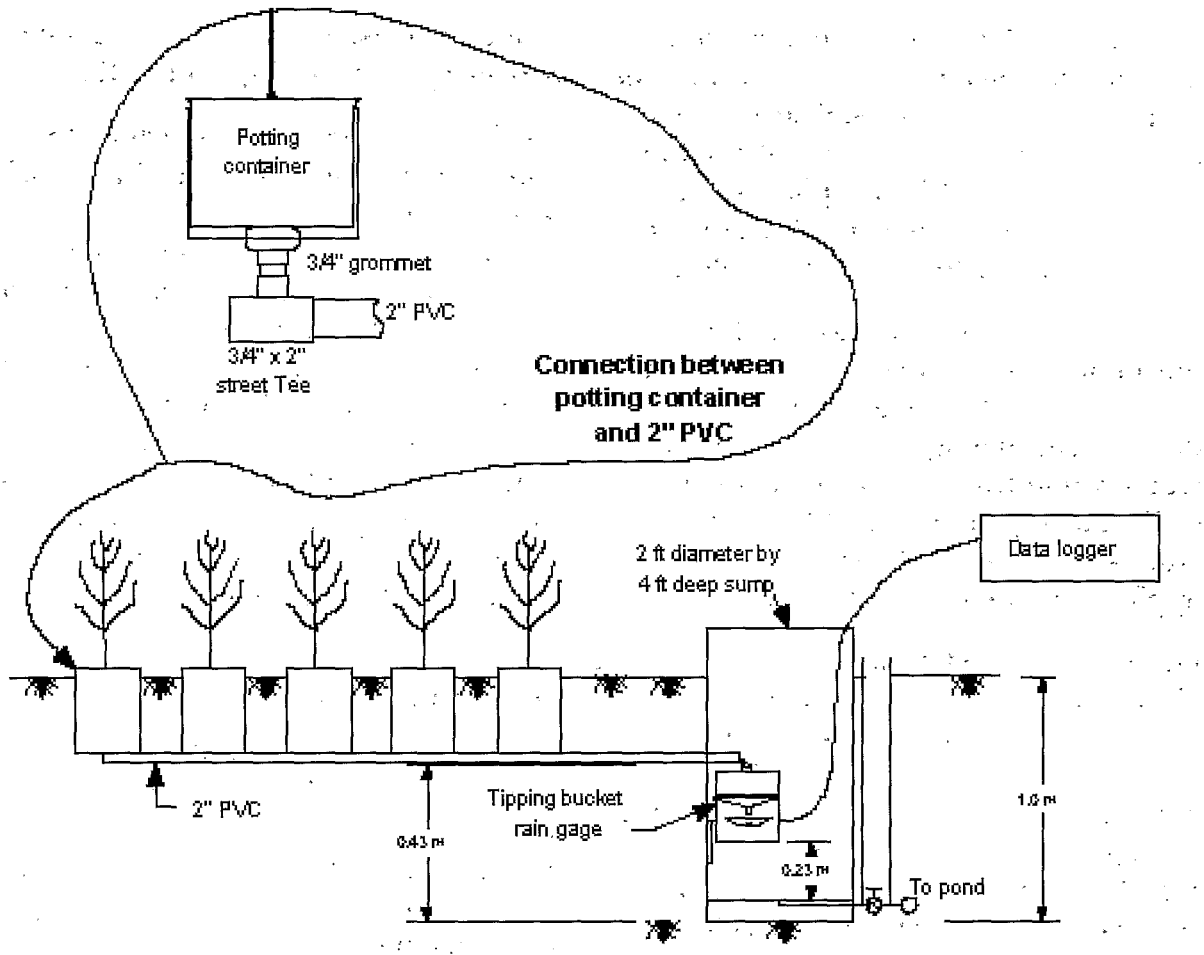

Figure 2: Diagram of the system to determine the amount of water runoff from five potting containers.

Weather Station

A moveable weather station equipped with a Campbell Scientific CM-6 system was installed near the experimental plot to measure precipitation, air temperature, relative humidity, solar radiation, atmospheric pressure, wind speed, and azimuth. The data are available on a network web site.

Data Collection

A Campbell Scientific CR23X data logger was used to process and acquire data from 10 rain gauges, 10 soil-moisture sensors, 10 thermocouples, and the total flow rate meter. The data logger was connected with two synchronous communication modules to allow multi-signal inputs simultaneously. The system collected data from rain gauges, moisture sensors, and thermocouples once a minute, while the total flow rate was collected each second only during the irrigation period.

Results and Discussion

The major goals for the year 2003 were to establish the experimental system and test the system reliability and accuracy for measuring water runoff, soil moisture, and temperature along with water chemical content and the relationship between water inputs and tree growth. After the system was established in July 2003, data were collected on the amount of

irrigation, water runoff, soil moisture, soil temperature, weather conditions, and tree caliper 18 cm above the soil surface. The leaching level of some chemical residues such as nitrogen (N), phosphate (P), and potassium (K) in water runoff were also detected weekly from water samples.

Preliminary test results indicated that the amount of water runoff varied with irrigation rate, tree sizes, and potting soil density. The average amount of weekly water runoff from each container was 0.27 L during the period of time between August 6 and August 26 when the average application rate was 1.0 L per day.

During the period of time between August 27 and September 16, we increased the daily application rate to 2.4 L in order to compare the runoff level with the previous application rate. Under this situation, the average weekly runoff from each container was 3.5 L. Apparently, the amount of water runoff greatly increased as the daily application rate increased.

Figure 3 shows the average weekly amount of nitrogen (N), phosphate (P) and potassium (K) leached in water runoff samples and irrigation water samples collected between July 9 and August 5. During this period of time, the average total amount of weekly water runoff from 50 potting containers was 38.4 L, while the total amount of water applied to 50 trees was 814 L per week. The ratio of the nutrition leaching level based on its concentration in irrigation water was 1.8 for nitrogen, 1.6 for phosphate, and 12.5 for potassium.

Soil moisture content averaged 47% at the time just after irrigation and dropped to 33% before the next irrigation. Soil temperature was between 20°C and 24°C during day and night when daily irrigation was applied. The average tree caliper increased from 1.4 cm to 2.1 cm between July 3 and September 17.

Further data analysis will include the annual water runoff and nutrition leaching level due to irrigation and rainfall, irrigation water use efficiency, tree size responding to variations of soil moisture and temperature due to changes in weather conditions. After multi-test results are obtained, we will determine if there are potential techniques to enable automatic irrigation scheduling for pot-in-pot tree nurseries to optimize tree productions with minimal water consumption and nutrient and pesticide leaching.

Acknowledgments

The authors wish to thank the following individuals — A. Doklovic, D. Troyer, B. Nudd, M. Sciarini, and D. Hammersmith for technical assistance and recommendations in establishing the experimental system.

Disclosures

Mention of trade names or commercial products in this article is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture and The Ohio State University.

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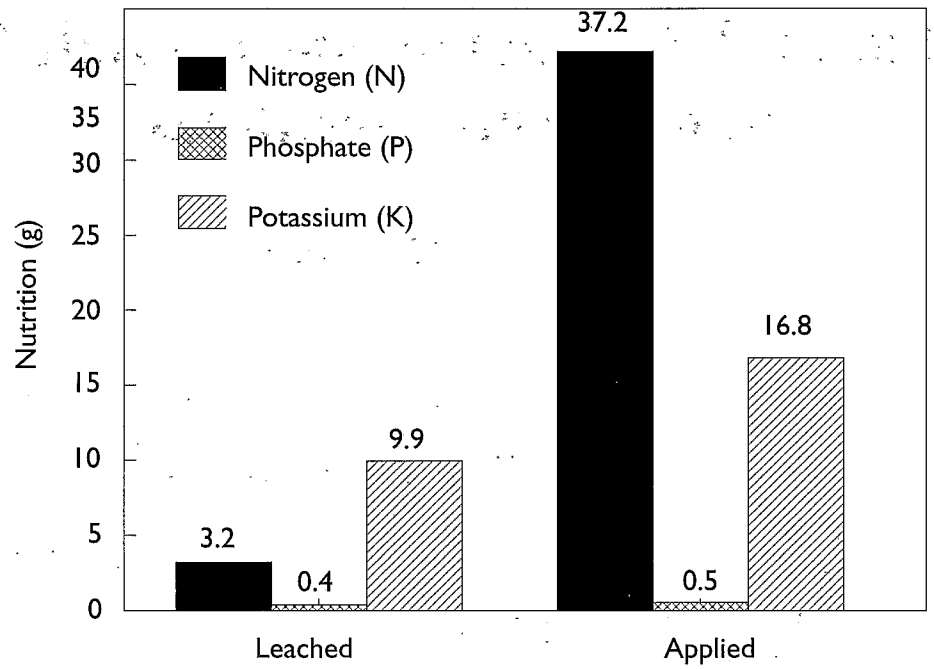

Figure 3. Average weekly nutrition leached and applied to five potting containers between July 9 and August 5.

~ 10 ~
Paclobutrazol-Soaked Ornamental Kale Seeds Produce Short Seedlings

Claudio C. Pasian and Mark A. Bennett

Abstract

Ornamental kale *(Brassica oleracea)* 'Nagoya Red' seeds were soaked in water or four paclobutrazol solutions for 5, 45, and 180 minutes. Treated and non-treated seeds were sown, one seed per cell, in 288 plug trays filled with a soilless plug mix. The percentage of usable plugs and the seedling heights were measured 13 and 20 days after sowing.

To study the long-term effect of paclobutrazol on kale plants, four seedlings per replication per treatment were transplanted 28 days after sowing in 15.3 cm diameter plastic containers using a commercial soilless medium. As long as growth regulator concentrations were not greater than 200 mg L-1 and times of soaking were not longer than 45 minutes, the percentage of usable transplants was not significantly reduced.

Significant trends in plug height reduction were measured with increasing concentrations of paclobutrazol. This significant trend was not noticeable on mature plants 116 days after planting.

It was also noted that plants from seeds soaked with paclobutrazol at a concentration of 500 mg L-1 or higher had thicker, straighter stems. It was speculated that after sowing, the active ingredient diffuses from the seed coats into the growing medium and is then absorbed by the seedling root after germination and emergence.

Introduction

A common challenge for transplant producers is height control. Many plant growth regulators (PGRs) are applied as foliar sprays or substrate drenches (Barrett and Nell, 1989; Dasoju *et al.*, 1998; Whipker and Hammer, 1997). Soil drenches with growth retardants are often preferred over foliar sprays because of the minimal drift of active ingredient, but paclobutrazol effectiveness may be reduced by growing medium composition (Million *et al.*, 1998).

Application of PGRs directly to seeds may circumvent some of these limitations for bedding plant production. The systemic properties of paclobutrazol and other triazoles (Davis *et al.*, 1988) have been shown to allow the application of growth retardants to seeds with no effect on seed germination (Pasian and Bennett, 2001).

The objective of this study was to compare germination, seedling survival, and seedling height of ornamental kale after soaking the seeds in varying paclobutrazol solutions at three different soaking times.

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Materials and Methods

Ornamental kale *(Brassica oleracea)* 'Nagoya Red' seeds were soaked in water or paclobutrazol solutions at 0, 50, 200, 500, or 1,000 mg L-1 for 5, 45, and 180 minutes. Nonsoaked seeds were used as a control. The beaker was agitated constantly during the soaking period. After soaking, seeds were dried for at least 16 hours at 25°C on an open bench.

Treated and nontreated seeds were sown one seed per cell in 288 plug trays (cell depth: 3.1 cm) filled with Sunshine LP5 (Sun Gro Horticulture, Bellevue, Wash.) plug mix. After sowing, seeds were covered with a small portion of the plug medium and placed under an intermittent light mist at 25°C for two to five days.

Plants were then moved to a greenhouse bench (temperature setting 22°C) and irrigated as needed with tap water. Plugs were watered as needed and fertilized with a 20N-8.7P-16.7K liquid fertilizer (Peters Professional7 water-soluble fertilizer, Scotts-Sierra Horticultural Products Company, Marysville, Ohio) at a rate of 200 mg L-1 three times a week.

The experiments were conducted in a completely randomized design using 20 seeds per replication with four replications per treatment. Plugs having healthy plants with no deformities and with signs of active growth were considered usable. The percent of usable plugs (the number of plugs : number of seeds sown ratio) and seedling height (the distance from the plug tray and the top of the seedling) were measured 13 and 20 days after sowing. On day 27 only seedling height was measured.

Four seedlings per replication per treatment were transplanted 28 days after sowing in 15.3 cm diameter (1800 ml) plastic containers using a commercial soilless growing medium (Metro-Mix7 360, Scotts-Sierra Horticultural Products Company, Marysville, Ohio) containing horticultural vermiculite, Canadian sphagnum peat moss, processed bark ash, and washed sand.

Forty-two days after sowing, height and diameter of the plants were recorded. Plants were measured for final height and diameter 116 days after sowing. After harvesting, plants were placed in a drying oven at 72°C for three days for dry weight determination.

Paclobutrazol rate responses to the PGR, seedling survival, and plant height were determined by regression analysis using the GLM procedure of SAS (SAS Institute, Cary, N.C.). Single degree of freedom contrasts were used to evaluate treatment effects.

Results and Discussion

Paclobutrazol seed-soaking solutions had a significant effect on the percentage of usable transplants or plugs (Table 1). As long as growth regulator concentrations were not greater than 200 mg L-1 and times of soaking were not longer than 45 minutes, usable transplant percentages were not significantly reduced below that of the control.

Significant trends in plug height reduction were detected with increasing concentrations of paclobutrazol (Table 2) for all three dates of measurements, indicating that the seedling height of ornamental kale may be controlled by soaking seeds in paclobutrazol.

Forty-two days after sowing, a significant trend of reduced plant height with increasing paclobutrazol concentrations was noticeable (Table 3). This trend was not significant on mature plants 116 days after planting. From a practical point of view, this is important because this

Table 1. Percent Ornamental Kale 'Nagoya Red' Seedling Survival 13 and 20 Days After Sowing From Seeds Soaked for 5, 45, or 180 Minutes in Four Paclobutrazol (Bonzi™) Solutions.						
	Usable Plugs (%)					
Treatment	5 min.		45 min		180 min.	
(mg L-1)	13 d	20 d	13 d	20 d	13 d	20 d
0	87.5	85.0	93.8	93.8	91.3	91.3
50	91.3	90.0	85.0	86.3	90.0	91.3
200	91.3	95.0	92.5	95.0	77.5	77.5
500	60.0	65.0	72.5	73.8	58.5	58.5
1,000	55.0	60.0	70.0	71.3	60.0	58.8
Significance						
Linear	**	*	**	**	*	*
Quadratic	NS	NS	NS	NS	NS	NS
NS, *, and ** : nonsignificant, significant and highly significant, respectively.						

Table 2. Ornamental Kale 'Nagoya Red' Seedling Height 13, 20, and 27 Days After Sowing From Seeds Soaked for 5, 45, or 180 Minutes in Four Paclobutrazol (Bonzi™) Solutions.									
	Seedling Height (cm)								
Treatment	5 min.			45 min			180 min.		
(mg L-1)	13 d	20 d	27 d	13 d	20 d	27 d	13 d	20 d	27 d
0	2.98	3.60	5.40	3.25	3.74	5.70	3.03	3.54	5.41
50	2.26	2.91	4.69	2.00	2.61	4.04	1.78	2.32	3.45
200	2.08	2.71	4.17	2.12	2.63	4.19	1.96	2.51	3.45
500	1.87	2.36	3.59	1.39	1.88	2.89	1.34	1.73	2.67
1,000	1.57	1.95	2.82	1.32	1.81	2.70	1.25	1.54	2.21
Significance	Pr > F								
Linear	**	**	**	**	**	**	**	**	**
Quadratic	NS	NS	NS	*	*	*	*	NS	
NS, *, and **: Nonsignificant, significant, and highly significant, respectively.									

Table 3. Height of Ornamental Kale 'Nagoya Red' Plants 42 and 116 Days After Sowing From Seeds Soaked for 5, 45, or 180 Minutes in Four Paclobutrazol (Bonzi™) Solutions.

Treatment mg L-1	Time of soaking					
	5 min		45 min		180 min	
	42 d	116 d	42 d	116 d	42 d	116 d
	Plant height (cm)					
0	8.0	23.3	8.5	23.3	8.9	23.3
50	9.1	22.8	7.5	23.0	8.0	23.3
200	8.5	23.8	8.5	24.3	6.9	22.3
500	6.0	22.5	5.6	23.3	5.63	21.8
1,000	5.3	22.0	4.6	21.0	4.2	21.5
Significance						
Linear	**	NS	**	NS	**	NS
Quadratic	*	NS	*	*	NS	NS

NS, *, and **: Nonsignificant, significant, and highly significant, respectively.

methodology would allow growers to have shorter seedlings and customers to enjoy large garden plants. No significant trends were noticed for plant diameter or dry weight (data not presented). It was also noted that plants from seeds soaked with paclobutrazol at concentration 500 mg L-1 or higher had thicker, straighter stems than plants from non-treated seeds or seeds treated at lower concentrations of PGR. At concentrations lower than 500 mg L-1, this effect was less noticeable and plants with crooked stems were more noticeable. More work will have to be done to quantify this difference.

The primary mode of action of paclobutrazol is by inhibition of gibberellin biosynthesis (Davis *et al.*, 1988). Based on these results, it is hypothesized that paclobutrazol may adhere to the seed coats rather than diffuse into the seed. It has been shown that tomato, pepper, leek, and onion have a semipermeable layer in the seed coats (Beresniewicz *et al.*, 1995a; 1995b). This layer, located at the innermost layer of the seed coats, has been found to be permeable to water while inhibiting amino acid leakage or uptake of tetrazolium or lanthanum salts. In the case of seeds treated with paclobutrazol, it is speculated that after sowing, the active ingredient likely diffuses from the seed coats into the growing medium and is then absorbed by the seedling root after germination and emergence.

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Herbicide Resistance: Development, Prevention, and Recognition

Hannah M. Mathers

Herbicides are applied either to the foliage of growing weeds (postemergence) or to the soil to prevent germination (preemergence). Postemergent foliar herbicides are either contact or systemic chemicals.

Contact herbicides weaken and disorganize the plant cell membranes, causing leakage and eventual localized death. An example of a contact herbicide is Gramoxone. Systemic herbicides include the phenoxy herbicides (for example, 2,4-D) and dicamba and glyphosate. Systemic herbicides are translocated throughout the plant to their sites of physiological action.

Preemergent herbicides (*e.g.*, Casoron, Surflan, Ronstar) are applied either to the soil or growing-medium surface and are usually absorbed by root systems or by emerging shoot tips as they make their way through the soil surface during seed germination. Preemergents must be dissolved in the soil/medium solution in order to be effective.

Herbicide resistance is the genetic capacity of a weed population to survive an herbicide treatment that under normal use would effectively control that weed population (Martin *et al.*, 2001). Herbicide-resistant plants are present in a population in very small numbers. The repeated use of one herbicide allows these few plants to survive and reproduce (Mallory-Smith *et al.*, 1999).

Another way herbicide resistance may develop that is thought to be less contributory is a genetic mutation. This occurs after the herbicide has been applied and provides resistance to the herbicide (Hager *et al.*, 1998). A dilemma that is facing many producers of various agricultural and horticultural crops, in many states, is the development of biotypes of weed species that are resistant to herbicides.

A biotype is defined as a population of weeds within a given species that possesses certain traits not common to the entire population. Although the problem of herbicide-resistant weeds is not widespread in nursery culture, nursery managers should become knowledgeable about how resistance develops so that the prevalence of resistant weeds can be minimized (Hager *et al.*, 1998).

Weed resistance to herbicides is not unique (Kendig and Fishel, 1996). Insecticide-resistant insects, fungicide-resistant fungal pathogens, and antibiotic-resistant bacteria were discovered long before herbicide-resistant weeds. Spreading dayflower *(Commelina diffusa)* was the first herbicide-resistant weed identified. It was found to be resistant to 2,4-D in 1957, in a Hawaii sugar field (Mallory-Smith *et al.*, 1999).

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Herbicide resistance was first reported in nurseries in 1970 (Prather *et al.*, 2000). Common groundsel *(Senecio vulgaris)* in a Washington state tree nursery was shown to be resistant to herbicides in the triazine chemical class (Prather *et al.*, 2000).

Not every weed control failure you encounter in the future will be due to resistant weeds. However, the appearance of herbicide resistance in plants today is increasing at an exponential rate (Prather *et al.*, 2000) and is affecting the nursery operator's choice of herbicide. Besides triazine resistance, there are biotypes of 172 weed species expressing resistance to 16 other herbicide classes (Prather *et al.*, 2000). Worldwide, there are more than 249 herbicide-resistant weedy biotypes in 47 countries (Martin *et al.*, 2001).

Mode-of-Action

Herbicides have a specific target site, a place in the plant where herbicides bind and inhibit function (Hall *et al.*, 1999). Herbicides with the same mode-of-action will have the same translocation (movement) pattern, produce similar injury symptoms (Ross and Childs, 1996), and frequently have the same application method, constraints, and even toxicological profile (Hall *et al.*, 1999).

One or more vital processes in the plant must be disrupted in order for herbicides to kill a weed. Many herbicide target sites are enzymes; however, there are exceptions. Some vital metabolic plant processes that herbicides act on include photosynthesis (capture of light and carbohydrate synthesis), amino acid and protein synthesis, fat (lipid) synthesis, pigment synthesis, nucleic acid synthesis (RNA - DNA essential to information storage and transfer), and maintenance of membrane integrity (Ross and Childs 1996). Disruption of mitosis (cell division) in plant meristems (shoots or roots), disruption of meiosis (division resulting in gamete and seed formation), interference of uptake of ions and molecules, translocation of ions and molecules and transpiration are some other ways herbicides act to kill plants. In North America, herbicides are divided into groups based on target site. Herbicides with different modes-of-action should be rotated.

Some commonly used ornamental herbicides can be divided into 13 different groups based on mode-of-action, as indicated in Table 1:

- Lipid synthesis inhibitors at acetyl CoA carboxylase (ACCase), such as the cyclohexanediones and aryloxyphenoxy-propionates.
- Branched-chain amino acid synthesis inhibitors at acetolactate synthase (ALS), such as the imidazolines and sulfonylureas.
- Microtubule assembly inhibitors or seedling root inhibitors, such as the dinitroanalines (DNAs) and pyridines.
- Plant growth regulators that mimic auxins in the plant, such as the

phenoxy acetic acids, benzoic acids, and picolinic acids.

- Photosystem II inhibitors such as the triazines.
- Photosystem II inhibitors with different binding behavior, such as the benzothiadiazoles.
- Photosystem II inhibitors with yet another different binding behavior, such as the ureas.
- Aromatic amino acid inhibitors at EPSP synthase such as glycines.
- Glutamine synthesis inhibitors such as phosphinic acid.
- Photosystem I electron diverters such as bipyridyliums.
- Cell division seedling shoot inhibitors such as chloroacetamides and acetamides.
- Cell wall synthesis inhibitors such as benzamides and nitriles.
- Cell membrane disruptors such as diphenyl ethers, oxadiazoles, and N-phenylphthalimides.

How Does Resistance Develop?

Some management practices increase the likelihood of developing herbicide resistance. Resistance is more likely to occur when the same herbicide, or herbicides having the same modes of action, are used repeatedly.

It was thought that not using herbicides from the same family would prevent resistance. However, this is no longer the case (Mallory-Smith *et al.*, 1999). For example, two chemically different groups of herbicides, the sulfonylureas and imidazolinones, have the same site of action.

Using these two herbicide families repeatedly could lead to herbicide resistant biotypes, even though different families of herbicides are being used. This type of resistance development would be called cross-resistance. Table 1 indicates chemical families that have been shown to result in cross-resistance among weed species (Prather *et al.*, 2000).

The two herbicides indicated earlier are applied at different times. The imidazolinones are preemergents, and the sulfonylureas are postemergents. Many nursery growers think applying herbicides at different times, *i.e.*, pre- or post-emergence, means they are applying herbicides with different modes-of-action; however, the example listed previously indicates that this is not true.

The current recommendation is to rotate herbicides with different sites of action. Do not make more than two consecutive applications of herbicides with the same site of action to the same field **(http:// agguide.agronomy.psu.edu/sect1/sec13f.htm, 2002).**

Two consecutive applications can mean single applications for two years *(i.e.,* spring 2003 and spring 2004), or two split applications in one year *(i.e.,* spring 2003 and fall 2003).

Monocultures often encourage the use of the same herbicide and are more likely to develop herbicide-resistant weeds (Martin *et al.*, 2001). Resistance is most likely to develop in annual weed species since they produce high numbers of seeds (for example, pigweed, lambsquarters, and foxtail). Resistance often occurs in the

Text continues on page 95

Table 1. Some Herbicides Registered for Use in Outdoor Ornamentals and Non-Crop Areas.

Mode of action, herbicide family, trade and common name, and application timing are indicated. PSI and PSII indicate photosystem I and II. Chemical families marked with the same herbicide resistance activity code (HRAC) have been shown to result in cross-resistance among weed species. (Source for codes, Prather *et al.*, 2000).

Mode-of-Action and HRAC	Herbicide Family	Trade Name	Active Ingredient Common Name	Application Timing
Amino acid synthesis Inhibitor (ALS inhibitor)				
A	Imidazolinones	Plateau	Ammonium salt	Pre
		Image	Ammonium salt	Pre
A	Sulfonylurea	Manage	Halosulfuron-methyl	Post
Amino acid synthesis inhibitor (EPSP synthase inhibitor)				
B	Glycine	Rattler	Glyphosphate isopropylamine salt	Post
		Roundup Pro DRY	Glyphosate monoammonium salt	Post
		Roundup Pro	Glyphosphate isopropylamine salt	Post
		Mirage	Glyphosphate isopropylamine salt	Post
		Silhouette	Glyphosphate isopropylamine salt	Post
		Prosecutor	Glyphosphate isopropylamine salt	Post
		Touchdown Pro	Sulfosate	Post
Cell wall synthesis inhibitor				
C	Benzamide	Gallery 75 DF	Isoxaben	Pre
		Snapshot 2.5 TG	Isoxaben + Trifluralin + Fertilizer	Pre
C	Nitrile	Casoron 4G	Dichlobenil	
Cell membrane disruptor (inhibits PS I)				
D	Bipyridylium	Reward L&A	Diquat dibromide	Post
		Starfire	Paraquat dichloride	Post
		Boa	Paraquat dichloride	Post
		Gramoxone	Paraquat dichloride	Post
Cell membrane disruptor (Inhibit PPO enzyme)				
E	Diphenyl ether	Goal 2XL	Oxyfluorfen	Pre
		OH II	Oxyfluorfen + Pendimethalin	Pre
		Rout 3G	Oryzalin + Oxyfluorfen	Pre
		Regal 0-0	Oxadiazon + Oxyfluorfen	Pre

Table 1 (continued). Some Herbicides Registered for Use in Outdoor Ornamentals and Non-Crop Areas.

Mode of action, herbicide family, trade and common name, and application timing are indicated. PSI and PSII indicate photosystem I and II. Chemical families marked with the same herbicide resistance activity code (HRAC) have been shown to result in cross-resistance among weed species. (Source for codes, Prather *et al.*, 2000).

Mode-of-Action and HRAC	Herbicide Family	Trade Name	Active Ingredient Common Name	Application Timing
E	Oxadiazole	Ronstar G	Oxadiazon	Pre
		Regal Star	Oxadiazon + Prodamine	Pre
		Kansel Plus	Oxadiazon + Pendamethalin	Pre
Cell membrane disruptor				
F	N-phenyl-phthalimides	SureGuard	Flumioxazin	Pre
		Broadstar*	Flumioxazin	Pre
Fatty acid syntheses Inhibitor (ACCase inhibitors)				
G	Cyclohexanediones	Vantage	Sethoxydim	Post
		Envoy	Clethodium	Post
G	Aryloxyphenoxy-propionate	Fusilade II	Fluazifop-p-butyl	Post
		Acclaim Extra	Fenoxaprop	Post
Growth regulator				
H	Phenoxy	Salvo	2,4-D Isoctyl (2-ethylhexyl) ester	Post
		Weedar 64	2,4-D Amine	Post
H	Benzoic acid	Banvel	Dicamba	Post
H	Picolinic acid	Garlon	Triclopyr	Post
		Lontrel T&O	Clopyralid	Post
		Stinger 3L	Clopyralid	Post
Glutamine synthesis inhibitor				
I	Phosphinic Acid	Finale	Glufosinate ammonium	Post
Non-mobile Photosynthetic Inhibitors (Inhibits PSII)				
J	Benzothiadiazole	Basagran	Sodium bentazon	Post
		Basagran T/O	Sodium bentazon	Post
Mobile PS II inhibitor				
K	Triazine	Atrazine 4L	Atrazine	Pre
		Atrazine 90Df	Atrazine	Pre
		Simazine 90WDG	Simazine	Pre
		Simazine 4L	Simazine	Pre
		Simazine 90 DF	Simazine	Pre
		Princep 4L	Simazine	Pre
		Caliber 90	Simazine	Pre

Table 1 (continued). Some Herbicides Registered for Use in Outdoor Ornamentals and Non-Crop Areas.

Mode of action, herbicide family, trade and common name, and application timing are indicated. PSI and PSII indicate photosystem I and II. Chemical families marked with the same herbicide resistance activity code (HRAC) have been shown to result in cross-resistance among weed species. (Source for codes, Prather *et al.*, 2000).

Mode-of-Action and HRAC	Herbicide Family	Trade Name	Active Ingredient Common Name	Application Timing
Mobile PS II inhibitor (Different binding behavior than triazines)				
L	Urea	Diuron 4L	Diuron	Pre
		Diuron 80DF	Diuron	Pre
		Diuron 80WDG	Diuron	Pre
Mitotic disruptors; Microtubule assembly inhibitors (Root meristem inhibitor)				
M	Pyridine	Dimension	Dithiopyr	Post
		Dimension EC	Dithiopyr	Post
		Dimension Ultra 2SC	Dithiopyr	Post
		Dimension Ultra WSP	Dithiopyr	Post
M	Dinitroaniline (DNAs)	Barricade 65WG	Prodiamine	Pre
		Barricade 4FL	Prodiamine	Pre
		Kerb 50WP	Prodiamine	Pre
		Hurdle 3.8 ASC	Pendimethalin	Pre
		AquaCap	Pendimethalin	Pre
		Pendulum 2G,	Pendimethalin	Pre
		Pendulum 3.3 EC	Pendimethalin	Pre
		Pre-M 60DG	Pendimethalin	Pre
		Corral 2.68G	Pendimethalin	Pre
		Rout	Oryzalin + Oxyfluorofen	Pre
		Snapshot 2.5 TG	Isoxaben + Trifluralin + Fertilizer	Pre
		Team Pro	Benefin + Trifluralin + Fertilizer	Pre
		Surflan AS T/O	Oryzalin	Pre
		Surflan Coated Granules	Oryzalin	Pre
		XL 2G	Oryzalin + Benefin	Pre
		Oryzalin 4 Pro	Oryzalin	Pre
		Treflan 5G	Trifluralin	Pre
		Treflan HFP	Trifluralin	Pre
		Trifluralin EC	Trifluralin	Pre
		OH II	Oxyfluorfen + Pendimethalin	Pre

Table 1 (continued). Some Herbicides Registered for Use in Outdoor Ornamentals and Non-Crop Areas.

Mode of action, herbicide family, trade and common name, and application timing are indicated. PSI and PSII indicate photosystem I and II. Chemical families marked with the same herbicide resistance activity code (HRAC) have been shown to result in cross-resistance among weed species. (Source for codes, Prather *et al.*, 2000).

Mode-of-Action and HRAC	Herbicide Family	Trade Name	Active Ingredient Common Name	Application Timing
Cell division inhibitor (Seedling shoot inhibitor)				
N	Acetamide	Pre-Pair	Napropamide	Pre
		Devrinol 2G	Napropamide	Pre
		Devrinol 50DF	Napropamide	Pre
N	Chloroacetamide	Pennant Magnum 7.62 EC	Metolachlor	Pre
N	Benzamide	Kerb WSP	Pronamide	Pre
Note: * Indicates product not currently labeled.				

absence of other control practices such as cultivation, other physical controls, and/or cultural controls (Hager *et al.*, 1998).

An integrated weed-management approach is important for all weed-control management programs but is especially relevant to managing herbicide resistance. Resistance also occurs often with herbicides that have the greatest efficacy on a specific species (Martin *et al.*, 2001).

The intense selection pressure imposed by these efficacious herbicides results in the survival of only the resistant individuals. These then are the only individuals that pass their genes to the next generation (Martin *et al.*, 2001).

Using herbicides that do not persist in the soil for a long time and are not applied repeatedly in a growing season reduces the selection of herbicide resistant weeds (Mallory-Smith *et al.*, 1999). Many nursery growers are concerned about herbicide residues, of soil-persistent herbicides, affecting the subsequent crop.

Many herbicides are broken down in soils by microbes. Some herbicides decompose within three to four weeks, like 2,4-D. Other compounds are more resistant to microbial breakdown and can persist longer than one year, like diuron and atrazine.

In general, any condition that favors the growth of microbes will hasten herbicide decomposition. Temperature, moisture, aeration, organic matter content, pH, minerals present, concentration of the herbicide, species of microbes present, the herbicide used, and soil preconditioning are all important factors.

A warm, moist, fertile soil is generally ideal for microbial breakdown of herbicides. These conditions are not always experienced. In a drought situation, where no irrigation is supplied, the herbicide remains on the dry surface of the soil. Microbes are not active in these conditions, and the herbicide not only fails to provide weed control but also may persist until the next season and cause crop damage.

Prevention of Herbicide Resistance

One way to prevent resistance is to not use persistent preemergents and to test to determine if herbicide residues exist on a site. One persistent ornamental preemergent is Casoron, which is tied up by organic matter and slowly decomposed by soil microbes.

Casoron residue damage would generally show up as one-directional rooting. Other injury symptoms of Casoron include leaf yellowing or veinal, interveinal, marginal, or overall chlorosis.

Simazine and Princep are other persistent preemergents that can buildup in soils with repeated applications over several years.

Simazine injury appears as yellowing or veinal, interveinal, marginal, or overall chlorosis. Injury appears first in the new growth, since the chemical is translocated to the growing point. The whole leaf may become chlorotic at high concentrations. Atrazine residues are more serious in northern climates as inactivation is very slow below 75 F°.

Soils can be chemically analyzed for herbicide residues, but this is expensive, complicated, and can be done only in specialized laboratories. Moreover, the results of the analysis do not indicate the effects on the next crop.

An inexpensive and fairly reliable way to determine herbicide carryover or residue is to make a crop biological assay — a bioassay. A bioassay determines the biological activity of a substance by testing its effect on a test plant or organism.

Bioassays should also be done if you are renting a parcel of land for which you do not know the cropping history.

Soil sampling for a crop bioassay is similar to sampling for fertilizer levels. Samples should be gathered from several areas of the field. Remember that the assay is only as reliable as the sample collected. If possible, a nontreated or check soil sample should be taken from an adjacent nontreated area for comparison.

If herbicide residues in the soil are suspected, certain plant species are better indicators of that herbicide than others. The plants in Table 2 are suggested bioassay species for the corresponding herbicides.

About 10 seeds should be planted per container. Do not plant excess seeds. If too many plants are used, the amount of herbicide in the soil may be diluted.

Injury symptoms on seedlings should become apparent anytime between emergence to three weeks, depending on the herbicide being tested. Water plants sparingly, but do not allow the soil to dry out.

Another way to prevent herbicide resistance is to scout fields regularly to identify resistant weeds. Irregular patches of a single weed species in a field may be an indicator of herbicide resistance, especially when:

- There are no other apparent application problems.
- Other weed species are controlled adequately.
- The weed species that is not controlled shows minimal or no herbicide symptoms.

Table 2. Bioassay Species Used for 10 Selected Herbicides (Washington State University, Cooperative Extension, 1987).		
Herbicide	**Trade Name**	**Bioassay Species**
Atrazine	Atrazine	Cucumber, oats, wheat, Japanese millet, tomato, pumpkin, pea
Dichlobenil	Casoron 4G	Carrot
Diuron	Diuron 4L, 80DF, 80 WDG	Cucumber, barley, oat, pumpkin, ryegrass
Metolachlor	Pennant Liquid	Japanese millet
Napropamide	Devrinol	Wheat
Oryzalin	Surflan	Oat, barley, wheat
Pronamide	Kerb	Wheat
Simazine	Princep Liquid	Oat, ryegrass, wheat, mustard, sugarbeet, tomato
Trifluralin	Treflan	Oat, barley, annual ryegrass, cucumber
2,4-D	Various	Cucumber, mustard, tomato

- There has been a previous failure with the same herbicide or with a herbicide with the same site of action.
- Records show repeated use of one herbicide or of herbicides with the same site of action (Mallory-Smith *et al.*, 1999).

Another important way to prevent resistance is to rotate crops and change tillage practices. This is the biggest dilemma for weed resistance in nursery production. Often the same crop may be on a field for several years.

Different crops usually require different herbicides; rotating crops can increase herbicide rotation. Although the same crop is on the field in nursery culture for many years, herbicides with different modes of action still need to be rotated. This poses more of a challenge in the nursery; however, it is no less important.

In annual agronomic crops, spring and winter crops may be alternated, meaning the field will be tilled at different times of the year. This is not the case in nursery / perennial crop production; therefore, more reliance should be placed on other non-chemical control methods such as hand weeding, mulching, or solarization of the soil.

Summary

Directed sprays of Glyphosate allow selective removal of weed species in established nursery plantings (Ahrens, 1980, and Haramaki *et al.*, 1980) without crop injury if proper application techniques are used. Preemergent herbicides, however, must be applied following Glyphosate application for residual weed control (Akers *et al.*, 1984).

Achieving satisfactory weed control in field-grown nursery crops generally requires more than one application of herbicides (Gilliam *et al.*, 1989). Spring and fall preemergent sprays are usually recommended.

Four preemergent herbicides that have been commonly used in such programs are Surflan, Princep, Barricade, and Goal. Goal and Princep, however, may cause injury to certain field-grown nursery crops, and so, in recent years, Gallery, a soil-active herbicide, has become more widely used.

Surflan is a nonvolatile herbicide that is primarily active against small-seeded annual broadleaf and grass species. Valor also now has a 24C designation in Ohio for field nursery stock. Valor is recommended for spring or fall application.

Tank mixing two herbicides such as Surflan/Gallery or Gallery/Barricade (no more than 2 to 3 lbs/season) for a fall- or late-summer application is a common nursery-field practice; however, there are some important principles to remember regarding tank mixes and herbicide resistance prevention.

First, the mixture must contain herbicides with different modes of action, which the herbicides listed here do have. Second, combinations that control a broad spectrum of weeds, *i.e.*, a mixture of grass and broadleaf herbicides, may make sense in terms of overall weed control, but these combinations are not a weed-resistance management strategy (Mallory-Smith *et al.*, 1999, and Martin *et al.*, 2001).

The mixture must have herbicides that act on the same weed species to effectively provide multiple modes of action (Martin *et al.*, 2001). This is especially true if a potentially resistant weed is present.

Some tank-mixes should always be avoided whether for overall or resistance management strategies. An example of a combination to avoid is making combinations of contact and systemic activity postemergents. Systemic herbicides are the herbicides of choice for perennial weed control. Although injury symptoms do occur sooner with systemic and contact combinations, perennial regrowth will be quicker (Derr 2001).

Weed escapes and resistance outbreaks are difficult to tell apart. A greenhouse test is required to confirm that a resistant biotype has developed. Weed escapes can be the result of poor herbicide performance.

Poor herbicide performance can be caused by many factors, including improper timing, lack of rain (if needed for activation), poor application coverage, plant stress, failure to use a needed additive, below- or above-usage rates, improper water volume, poor water quality, improper nozzles, and soil type to name a few.

Much time is spent arguing about terminology. Is Johnsongrass resistant to atrazine? Is pigweed resistant to Fusilade? Actually, atrazine has never worked on Johnsongrass, and Fusilade has never worked on pigweed. *Tolerant* would be a better word to describe the response of Johnsongrass and pigweed to atrazine and Fusilade, respectively (Kendig and Fishel, 1996).

Regardless of terminology, the issue today is that weeds that once were controlled are now tolerant to particular herbicides. By adopting proactive management strategies designed to prevent herbicide resistance, we can conserve important weed-control tools (Prather *et al.*, 2000).

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Ohio State University Extension 2003 Herbaceous Ornamental Field Trial Results

Pamela J. Bennett

Introduction and Methods

Clark County Ohio State University Master Gardener volunteers have evaluated annual plant varieties since 1995. Carolyn Allen and Barbara Brown are Master Gardener volunteer co-chairs of the project. The field trial plots are located at the Gateway Learning Gardens at the Clark County Extension Office in Springfield, Ohio, and are planted and maintained by volunteers. The plots are typical of the west-central Ohio area; the soil is predominantly clay with a pH of 7.3. The current plots were established in the fall of 1996. The beds were tilled to a depth of 14", and 2" of compost was added when new beds were established and every three years. Compost was added to all beds in the fall of 2002. There is approximately 5,000 square feet of bed space in full sun and approximately 1,000 square feet in shade.

The selection of plants to be trialed in the garden varies from year to year. The selection is based on performance in prior years, on current trends, and on industry recommendations. The purpose of the evaluation is to provide growers, landscapers, and homeowners a guide for plant selection for Ohio.

Pamela J. Bennett, Ohio State University Extension, Horticulture, Clark County.

Method

The plants were started from seed, plugs, or cuttings at a local greenhouse, according to the recommended starting dates. They were planted in the plots on May 28, 2003. The rows were spaced 2' apart; 6 plants of each variety are in each row. Trailing or vining plants were spaced 4' apart with 4' between rows. Osmocote® (14-14-14) was incorporated prior to planting at the labeled rate. Beds were hand weeded as needed throughout the season.

Irrigation was applied during dry periods so that plants received at least 1" of water per week. See the section on weather information for details. No additional applications of fertilizers were made. The plants were not deadheaded or pruned during the growing season. No insecticides or fungicides were applied. Volunteers weeded the plots as needed; no mulch was used. Plants were grown in full sun, unless otherwise indicated. The material for the shade house provided a 75% shade.

Three people conducted visual evaluations in June, July, and August. The entire row was given a visual rating from 1 to 5. If there were less than three plants remaining in one row at any time during the evaluation, the variety was

dropped from the trials. A rating of 5 was considered to be excellent and a rating of 1 was considered to be poor. The three individual evaluation ratings were averaged for the monthly rating figure. Then, the monthly evaluations were averaged for the overall rating for each variety.

Weather Information

Precipitation for May was above average while temperatures were slightly below to normal. Despite wet soil conditions during most of May, the annuals were planted under excellent soil conditions.

Temperatures were below normal in June, July, and August. There were only three days above 90°F in 2003 as compared to 30 days above 90°F in 2002. Precipitation was well above normal in July and August. Supplemental irrigation was applied in order to provide 1" of water per week; however, this year, it was only applied in the beginning in order to establish plants. There was one other time in late August that additional irrigation was required. Weather conditions for this growing season as well as normal average temperatures and precipitation are shown here.

Temperature	May	June	July	August	Sept.
2003 average high temperature F°	69.9 F°	77.4 F°	82.8 F°	82.6 F°	73.7 F°
2003 average low temperature F°	51.3 F°	56.7 F°	62.1 F°	62.5 F°	52.6 F°
2003 average temperature F°	60.0 F°	66.7 F°	71.8 F°	71.5 F°	62.7 F°
Normal average temperature F°	61.3 F°	70.3 F°	73.8 F°	72.0 F°	65.2 F°
Precipitation					
Normal average rainfall (inches)	4.59"	4.16"	4.08"	3.50"	2.99"
2003 rainfall (inches)	7.10"	3.67"	8.82"	6.26"	8.11"
Days over 90°F	0	0	3	0	0

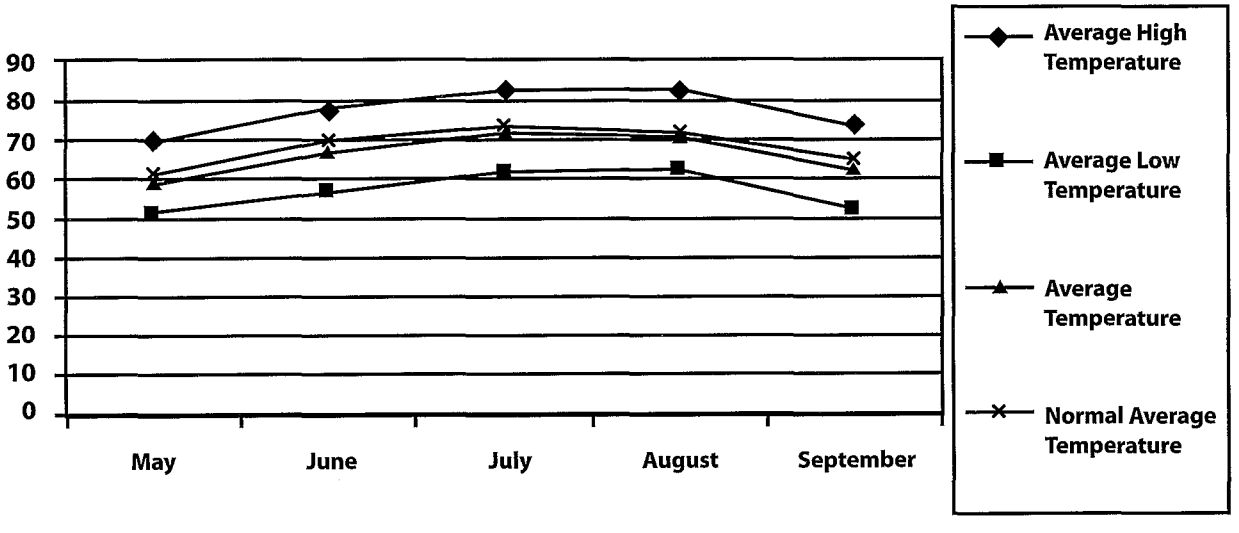

Table 1 lists the varieties in the 2003 field trials and their monthly ratings and overall rating. The **plants listed in bold** are those varieties that were grown under the shade structure (75% shade cloth).

The supplier for each annual is listed in the table. The supplier key is at the end of the table. The plants are listed in order of their Overall Rating, for each species, from highest to lowest.

Table 1. Herbaceous Ornamental Field Trial Results, 2003.

Plant	Supplier	June	July	August	Overall Rating
Abutilon x *hybridum* 'Souvenir de Bonn'	DSC	2.67	2.67	3.67	3.00
Ageratum houstonianum 'Leilania Blue'	GS	3.33	3.67	4.33	3.78
Ageratum houstonianum 'Pearl Royal'	PAS	3.00	4.00	2.67	3.22
Alonsoa meridionalis 'Rebel'	K	2.67	2.00	1.00	1.89
Alternanthera 'Purple Knight'	PAS	3.67	5.00	5.00	4.56
Ammobium alatum 'Bikini'	BS	3.67	4.00	2.00	3.22
Angelonia 'Angelmist® Light Pink'	BFP	3.33	4.67	5.00	4.33
Angelonia 'Angelmist® Lavender Imp.'	BFP	3.33	4.67	5.00	4.33
Angelonia 'Angelmist® Purple Stripe'	BFP	3.33	4.67	4.67	4.22
Angelonia 'Angelmist® Purple Imp'	BFP	3.33	4.67	4.67	4.22
Angelonia 'Angelmist® Lavender Pink'	BFP	3.00	4.67	5.00	4.22
Angelonia 'Blue Angel'	DSC	2.67	4.67	5.00	4.11
Angelonia 'Angelmist® Deep Plum Imp.'	BFP	3.00	4.33	5.00	4.11
Angelonia 'Angelmist® White Cloud'	BFP	2.67	4.33	4.67	3.89
Argyranthemum hybrid 'Vanilla Butterfly'	PW	4.00	5.00	4.33	4.44
Argyranthemum hybrid 'Molimba Helio White'	PW	3.33	4.00	3.00	3.44
Argyranthemum hybrid 'Comet Pink'	DSC	3.67	4.33	1.50	3.17
Argyranthemum hybrid 'Comet White'	DSC	3.33	3.67	1.67	2.89
Bacopa 'Breeze Lavender'	BFP	4.67	4.67	1.67	3.67
Bacopa 'Candy Floss Blue'	DSC	3.67	4.00	1.67	3.11
***Bacopa* 'Blue Showers'**	**DSC**	**4.00**	**2.67**	**2.00**	**2.89**
***Bacopa* 'Breeze Pink'**	**BFP**	**3.33**	**3.67**	**1.67**	**2.89**
***Bacopa* 'Penny Candy Violet'**	**DSC**	**3.67**	**4.00**	**1.00**	**2.89**
Begonia x *hybrida* ' Harmony Scarlet'	BallSd	3.00	4.33	4.67	4.00
Begonia x *hybrida* 'Harmony Pink Imp'	BallSd	3.00	4.00	4.67	3.89
Begonia x *hybrida* 'Harmony White Imp'	BallSd	2.67	4.33	4.67	3.89
Begonia x *hybrida* 'Prelude Pink Imp'	BallSd	3.00	4.00	4.67	3.89
Begonia argenteoguttata 'Dragon Wing® Pink'	PAS	3.00	4.00	4.67	3.89
Begonia x *semperflorens* 'Party Mix'	BS	2.67	4.00	5.00	3.89
Begonia x *semperflorens* 'Olympia Sprint Rose'	BS	2.67	4.00	4.67	3.78

Table 1 (continued). Herbaceous Ornamental Field Trial Results, 2003.					
Plant	**Supplier**	**June**	**July**	**August**	**Overall Rating**
Begonia x *hybrida* 'Prelude White Imp'	BallSd	2.67	3.67	4.67	3.67
Begonia x *semperflorens* 'Olympia Sprint Red'	BS	2.67	3.33	4.33	3.44
Begonia x *semperflorens* 'Lotto Pink'	BS	3.00	3.33	3.67	3.33
Begonia x *semperflorens* 'Olympia Sprint White'	BS	2.67	3.67	3.67	3.33
Begonia x *semperflorens* 'Olympia Sprint Bicolor'	BS	2.67	3.00	4.00	3.22
Begonia x *hybrida* 'Prelude Scarlet'	BallSd	2.67	3.00	3.67	3.11
Begonia x *semperflorens* 'Victory Br Leaf White'	GS	2.67	3.00	3.67	3.11
Begonia x *semperflorens* 'Lotto White'	BS	2.67	3.00	3.33	3.00
Begonia x *semperflorens* 'Olympia Sprint Mix'	BS	2.67	2.67	3.33	2.89
Begonia x *semperflorens* 'Gumdrops Tangerine'	OSUG	2.00	2.33	1.67	2.00
***Begonia rex* 'Flamingo Shoals'**	**DSC**	**1.67**	**2.33**	**2.00**	**2.00**
Bidens ferulifolia 'Peter's Gold Carpet'	PW	3.67	4.00	4.00	3.89
Bracteantha x *hybrid* 'Sundaze Bronze'	PW	3.67	5.00	4.00	4.22
Bracteantha hybrid 'Sundaze Golden Beauty'	PW	3.33	5.00	2.00	3.44
Calibrachoa 'Million Bells Trailing Magenta'	JP	3.00	3.67	2.67	3.11
Calibrachoa 'Million Bells Pink Kiss'	PW	3.00	3.67	2.00	2.89
Calibrachoa 'Million Bells Red'	JP	2.67	3.33	1.33	2.44
Calibrachoa 'Million Bells Trailing Rose'	PW	2.00	3.00	1.67	2.22
Calibrachoa 'Million Bells Trailing Blue'	JP	1.67	2.33	1.67	1.89
Calibrachoa 'Million Bells Trailing Blue'	PW	2.00	1.67	1.67	1.78
Capsicum annuum 'Numex Twilight'	OSUG	3.67	4.67	5.00	4.44
Capsicum annuum 'Bolivian Rainbow'	OSUG	3.67	4.67	5.00	4.44
Capsicum annuum 'Pepper Marbles'	OSUG	3.67	4.67	4.67	4.33
Capsicum annuum 'Masquerade'	PAS	3.00	5.00	4.00	4.00
Capsicum annuum 'Poinsettia'	OSUG	3.67	4.00	4.33	4.00
Capsicum annuum 'Red Missile'	PAS	2.67	4.67	3.33	3.56
Capsicum annuum 'Holiday Flame'	PAS	2.67	4.67	2.67	3.33
Capsicum annuum 'Chilly Chili'	PAS	2.67	4.67	2.00	3.11
Capsicum annuum 'Medusa'	PAS	2.67	4.00	1.67	2.78
Catharanthus roseus 'Blue Pearl'	PAS	3.33	4.67	5.00	4.33
Catharanthus roseus 'Cooler™ Lavender Halo'	PAS	2.67	5.00	5.00	4.22
Catharanthus roseus 'Cooler™ Peppermint'	PAS	3.00	4.67	5.00	4.22
Catharanthus roseus 'Cooler™ Coconut Improved'	PAS	2.67	4.67	5.00	4.11
Catharanthus roseus 'Cooler™ Rose Hot'	PAS	2.67	4.67	5.00	4.11
Catharanthus roseus 'Cooler™ Orchid Deep'	PAS	2.33	4.67	5.00	4.00

Table 1 (continued). Herbaceous Ornamental Field Trial Results, 2003.					
Plant	**Supplier**	**June**	**July**	**August**	**Overall Rating**
Catharanthus roseus 'Pacifica Mix'	PAS	2.33	4.33	5.00	3.89
Catharanthus roseus 'Pacifica Burgundy'	PAS	2.67	4.00	4.67	3.78
Catharanthus roseus 'Pacifica Icy Pink'	PAS	2.00	4.00	5.00	3.67
Catharanthus roseus 'Pacifica Polka Dot'	PAS	2.00	4.00	4.67	3.56
Celosial spicata 'Punky Red'	K	3.67	4.67	5.00	4.44
Celosia cristata 'New Look'	BS	2.67	4.67	4.67	4.00
Celosia argentea 'Glow Carmine'	PAS	3.33	3.33	3.00	3.22
Celosia cristata 'Amigo Mahogany Red'	BS	3.00	3.00	1.67	2.56
Celosia spicata 'Spiky Pinky'	K	2.67	2.33	1.33	2.11
Cleome spinosa 'Goldstart Sparkler Mix'	GS	3.33	5.00	4.67	4.33
Cleome spinosa 'Queen Cherry'	BallSd	4.00	4.33	4.67	4.33
Cleome rosea 'Linda Armstrong'	MG	3.33	4.33	3.33	3.67
Coleus x _hybrida_ x _hybrida_ 'Alabama Sunset'	**MG**	**4.67**	**5.00**	**5.00**	**4.89**
Coleus x _hybrida_ x _hybrida_ 'Solar Sunrise'	**MG**	**4.67**	**5.00**	**5.00**	**4.89**
Coleus x _hybrida_ 'Molten Lava'	**DSC**	**4.33**	**5.00**	**5.00**	**4.78**
Coleus x _hybrida_ 'Tilt-a-Whirl'	**DSC**	**4.33**	**5.00**	**5.00**	**4.78**
Coleus x _hybrida_ 'Peter's Wonder'	**DSC**	**4.33**	**5.00**	**5.00**	**4.78**
Coleus x _hybrida_ 'Trailing Rose'	**DSC**	**4.33**	**5.00**	**5.00**	**4.78**
Coleus x _hybrida_ 'Super Duckfoot'	**MG**	**4.00**	**5.00**	**5.00**	**4.67**
Coleus x _hybrida_ 'Dark Heart'	**DSC**	**4.00**	**5.00**	**5.00**	**4.67**
Coleus x *hybrida* 'Sorcerer'	OSUG	2.67	3.33	1.67	2.56
Cosmos bipinnatus 'Sonata™ Carmine'	PAS	3.67	4.00	2.67	3.44
Cosmos bipinnatus 'Sonata™ White'	PAS	3.33	4.00	2.67	3.33
Cosmos bipinnatus 'Sonata™ Pink'	PAS	3.67	4.00	2.00	3.22
Dianthus 'Rose Magic'	PAS	3.33	5.00	4.00	4.11
Dianthus barbatus 'Amazon Neon Purple'	PAS	3.33	5.00	3.67	4.00
Dianthus barbatus 'Amazon Neon Cherry'	PAS	3.33	5.00	3.33	3.89
Dianthus chinensis 'Magic Charms Coral'	GS	4.00	5.00	1.67	3.56
Dianthus barbatus 'Dynasty White Blush'	BallSd	3.33	5.00	2.00	3.44
Dianthus 'Floral Lace Cherry'	BallSd	3.33	5.00	2.00	3.44
Dianthus 'Ideal Formula Mix'	PAS	3.67	4.67	2.00	3.44
Dianthus chinensis 'Floral Lace Purple'	BallSd	3.67	5.00	1.67	3.44
Dianthus chinensis 'Magic Charms Pink'	GS	3.67	5.00	1.67	3.44
Dianthus barbatus 'Dynasty Red'	BallSd	3.33	4.67	2.00	3.33
Dianthus chinensis 'Panda Mix'	BallSd	3.33	4.67	2.00	3.33
Dianthus barbatus 'Dynasty Purple'	BallSd	3.33	4.67	1.67	3.22
Dianthus chinensis 'Strawberry Super Parfait'	GS	3.67	4.67	1.00	3.11

Table 1 (continued). Herbaceous Ornamental Field Trial Results, 2003.					
Plant	Supplier	June	July	August	Overall Rating
Dianthus chinensis 'Magic Charms White'	GS	3.67	4.33	1.00	3.00
Dianthus chinensis 'Raspberry Super Parfait'	GS	3.33	3.67	1.00	2.67
Diascia 'Sun Chimes Coral'	DSC	5.00	4.67	2.67	4.11
Diascia x hybrida 'Flying Color Trailing Red'	PW	4.67	5.00	2.33	4.00
***Dichondra repens* 'Silver Falls'**	**PAS**	**3.67**	**4.67**	**5.00**	**4.44**
***Dichondra repens* 'Emerald Falls'**	**PAS**	**3.33**	**4.00**	**4.33**	**3.89**
Euryops 'Sonnenschein'	DSC	4.00	4.00	3.33	3.78
Graptophyllum pyctum 'Chocolate'	MG	3.00	4.00	5.00	4.00
Graptophyllum pyctum 'Tri-color'	MG	3.00	4.00	5.00	4.00
Gypsophila 'Festival Star'	PW	3.00	3.33	2.33	2.89
***Impatiens wallerana* 'Superbowl Salmon'**	**DSC**	**4.33**	**5.00**	**5.00**	**4.78**
NG *Impatiens* 'Infinity Lavender Pink'	**PW**	**4.00**	**5.00**	**5.00**	**4.67**
NG *Impatiens* 'Infinity Lilac'	**PW**	**4.00**	**5.00**	**5.00**	**4.67**
NG *Impatiens* 'Infinity Cherry Red'	**PW**	**4.00**	**5.00**	**4.67**	**4.56**
NG *Impatiens* 'Infinity Dark Salmon Glow'	**PW**	**3.67**	**5.00**	**5.00**	**4.56**
NG *Impatiens* 'Infinity Scarlet'	**PW**	**4.00**	**4.67**	**4.67**	**4.44**
NG *Impatiens* 'Infinity Red'	**PW**	**4.00**	**5.00**	**4.33**	**4.44**
***Impatiens wallerana* 'Superbowl Vivid Purple'**	**DSC**	**4.00**	**4.00**	**5.00**	**4.33**
NG *Impatiens* 'Infinity White'	**PW**	**4.33**	**4.67**	**4.00**	**4.33**
NG *Impatiens* 'Infinity Light Purple'	**PW**	**3.67**	**4.33**	**5.00**	**4.33**
NG *Impatiens* 'Infinity Lavender'	**PW**	**3.33**	**4.33**	**5.00**	**4.22**
NG *Impatiens* 'Infinity Orange'	**PW**	**3.67**	**4.67**	**4.33**	**4.22**
NG *Impatiens* 'Infinity Pink'	**PW**	**3.67**	**4.67**	**4.33**	**4.22**
NG *Impatiens* 'Infinity Pink Frost'	**PW**	**3.67**	**4.33**	**4.67**	**4.22**
NG *Impatiens* 'Infinity Salmon'	**PW**	**3.67**	**4.33**	**4.67**	**4.22**
NG Impatiens 'Infinity Blush Lilac'	**PW**	**3.33**	**4.67**	**4.33**	**4.11**
NG Impatiens 'Infinity Dark Pink'	**PW**	**3.00**	**4.33**	**5.00**	**4.11**
***Impatiens wallerana* 'Summer Ice Snow 'N Ice'**	**DSC**	**2.67**	**4.33**	**4.00**	**3.67**
NG *Impatiens wallerana* 'Infinity Pink Kiss'	**PW**	**2.67**	**4.00**	**4.00**	**3.56**
NG *Impatiens* 'Celebrette Grape Crush Imp'	**BFP**	**3.00**	**3.00**	**3.33**	**3.11**
Iresine herbstii 'Purple Lady'	PAS	4.00	4.33	4.00	4.11
Lantana camera 'Patriot Hallelujah'	MG	4.33	5.00	5.00	4.78
Lantana camera 'Patriot Hot Country'	MG	3.67	4.00	5.00	4.22
Lantana camera 'Patriot Rainbow'	MG	3.33	4.00	4.33	3.89
Lantana camera 'Lucky Peach Sunrise'	BFP	2.33	4.33	5.00	3.89

Table 1 (continued). Herbaceous Ornamental Field Trial Results, 2003.					
Plant	Supplier	June	July	August	Overall Rating
***Lobelia erinus* 'Laguna Sky Blue'**	**PW**	**5.00**	**5.00**	**4.33**	**4.78**
***Lobelia erinus* 'Big Blue'**	**DSC**	**5.00**	**4.67**	**3.33**	**433**
***Lobelia erinus* 'Blue Moon '**	**BallSd**	**4.33**	**5.00**	**3.67**	**4.33**
Melampodium paludosum 'Melanie'	K	3.67	5.00	5.00	4.56
Monopsis inodetata 'Blue Papillio'	BFP	4.33	4.67	3.67	4.22
***Nemesia fruticans* 'Sachet Blueberry'**	**DSC**	**5.00**	**5.00**	**5.00**	**5.00**
***Nemesia fruticans* 'Sachet Parfait'**	**DSC**	**5.00**	**5.00**	**4.33**	**4.78**
Nemesia fruticans 'Sunsatia Peach'	PW	3.33	3.33	2.67	3.11
Pennisetum glaucum 'Ornamental Millet Purple Majesty F1'	PAS	3.67	4.67	4.67	4.33
Perilla 'Magilla'	BFP	5.00	5.00	5.00	5.00
Petunia x *hybrida* 'Tidal Wave Purple'	BallSd	4.67	5.00	5.00	4.89
Petunia x *hybrida* 'Storm Pink Morn'	GS	4.67	5.00	4.67	4.78
Petunia x *hybrida* 'Storm Salmon'	GS	4.67	5.00	4.67	4.78
Petunia x *hybrida* 'Hurrah White Improved'	SG	4.33	5.00	5.00	4.78
Petunia x *hybrida* 'Sky Blue'	SG	4.33	5.00	5.00	4.78
Petunia x *hybrida* 'Storm Violet'	GS	4.67	4.67	5.00	4.78
Petunia x *hybrida* 'Carpet Rose Star'	PAS	4.00	5.00	5.00	4.67
Petunia x *hybrida* 'Hurrah Lavender Tie Die'	SG	4.33	4.67	5.00	4.67
Petunia x *hybrida* 'Hurrah Pink Chiffon'	SG	4.33	4.67	5.00	4.67
Petunia x *hybrida* 'Ultra Salmon'	GS	4.33	5.00	4.67	4.67
Petunia x *hybrida* 'Storm Blue'	GS	4.67	5.00	4.33	4.67
Petunia x *hybrida* 'Storm White'	GS	4.67	4.67	4.67	4.67
Petunia x *hybrida* 'Hurrah Velvet'	SG	4.33	4.67	4.67	4.56
Petunia x *hybrida* 'Wave Pink Improved'	PAS	3.67	5.00	5.00	4.56
Petunia x *hybrida* 'Ultra White'	GS	4.00	4.67	4.67	4.44
Petunia x *hybrida* 'Ramblin Violet'	GS	3.67	4.67	5.00	4.44
Petunia x *hybrida* 'Hurrah Coral Flare'	SG	3.67	4.67	5.00	4.44
Petunia x *hybrida* 'Ramblin Rose Pink'	GS	3.33	4.67	5.00	4.33
Petunia x *hybrida* 'Bravo Appleblossum'	SG	4.00	4.67	4.33	4.33
Petunia x *hybrida* 'Ultra Pastel Pink'	GS	4.33	4.67	4.00	4.33
Petunia x *hybrida* 'Ultra Red'	GS	3.67	4.33	4.67	4.22
Petunia x *hybrida* 'Ramblin Peach Glo'	GS	3.00	4.00	5.00	4.00
Petunia x *hybrida* 'Madness Double Pink'	BallSd	3.00	4.33	4.67	4.00
Petunia x *hybrida* 'Ramblin Burgundy Chrome'	GS	2.67	3.67	4.67	3.67
Petunia x *hybrida* 'Ramblin Red'	GS	3.00	3.33	4.67	3.67

Table 1 (continued). Herbaceous Ornamental Field Trial Results, 2003.					
Plant	**Supplier**	**June**	**July**	**August**	**Overall Rating**
Petunia x *hybrida* 'Double Pirouette Red'	PAS	2.67	3.67	4.67	3.67
Petunia x *hybrida* 'Wave Blue'	PAS	2.67	3.33	3.33	3.11
Phlox x *hybrid* 'Intensia Lavender Glow'	PW	3.67	5.00	5.00	4.56
Phlox x *hybrid* 'Intensia Lilac Rose'	PW	3.67	5.00	5.00	4.56
Phlox x *hybrid* 'Intensia Neon Pink'	PW	3.67	5.00	4.00	4.22
Phlox drummondi 'Grammy Pk/White'	K	2.00	3.33	2.00	2.44
Portulaca grandiflora 'Scarlet'	PAS	2.00	3.33	4.33	3.22
Potato Vine 'Aurea'	DSC	4.00	4.33	4.33	4.22
Rudbeckia hirta 'Cordoba'	BS	3.33	4.00	3.67	3.67
Rudbeckia hirta 'Prairie Sun'	BS	2.67	3.67	4.67	3.67
Rudbeckia hirta 'Autumn Colors'	BS	2.67	3.33	4.33	3.44
Rudbeckia hirta 'Chim Chiminee'	TM	2.67	3.33	4.33	3.44
Salvia splendens 'Salsa Purple'	GS	4.00	4.67	4.67	4.44
Salvia farinacea 'Vista Purple'	PAS	4.00	4.67	4.67	4.44
Salvia splendens 'Salsa Scarlet'	GS	4.33	4.33	4.67	4.44
Salvia farinacea 'Picante Scarlet'	GS	4.00	4.33	4.67	4.33
Salvia farinacea 'Victoria Blue'	BallSd	3.33	4.67	5.00	4.33
Salvia farinacea 'Victoria White'	BallSd	3.67	4.67	4.67	4.33
Salvia farinacea 'Vista Red White'	PAS	4.00	4.67	3.67	4.11
Salvia farinacea 'Picante Salmon'	GS	3.67	4.33	4.33	4.11
Salvia farinacea 'Blue Ribbon'	PAS	3.00	4.33	4.67	4.00
Salvia patens 'Blue Angel'	BS	3.67	4.67	3.33	3.89
Salvia farinacea 'Black and Blue'	BFP	3.33	3.33	4.67	3.78
Sanvitalia procumbens 'Aztec Gold'	BS	3.00	4.33	3.67	3.67
Scaevola 'Whirlwind White'	PW	4.00	4.33	2.67	3.67
Spilanthes 'Peek-a-Boo'	PAS	3.67	4.67	4.33	4.22
Tagetes (marigold) 'Marvelous Orange'	S	5.00	5.00	4.67	4.89
Tagetes (marigold) 'Marvelous Yellow'	S	5.00	4.67	4.67	4.78
Tagetes (marigold) 'Durango Yellow Improved'	PAS	4.67	5.00	4.67	4.78
Tagetes (marigold) 'Aspen Yellow'	S	4.67	5.00	4.33	4.67
Tagetes (marigold) 'Durango Tangerine'	PAS	4.67	5.00	4.33	4.67
Tagetes (marigold) 'Marvelous Flame'	S	5.00	5.00	3.67	4.56
Tithonia 'Fiesta Del Sol'	BS	2.67	4.00	4.67	3.78
Trachelium caeruleum 'Devotion Purple'	PAS	2.67	4.00	3.00	3.22
Verbena hybrida 'Babylon Deep Pink'	PW	4.33	4.67	5.00	4.67
Verbena rigida 'Santos'	K	2.67	4.67	5.00	4.11

Table 1 (continued). Herbaceous Ornamental Field Trial Results, 2003.					
Plant	**Supplier**	**June**	**July**	**August**	**Overall Rating**
Verbena tenuisecta 'Tapiens Blue Violet'	JP	4.00	4.33	3.67	4.00
Verbena hybrida 'Babylon Neon Rose'	PW	3.67	4.33	3.67	3.89
Verbena 'Temari Patio Rose'	JP	3.33	3.67	2.67	3.22
Verbena hybrida 'Quartz Burgundy'	PAS	2.67	4.00	1.67	2.78
Verbena 'Aztec® Lilac Picotee'	BFP	3.67	3.33	1.00	2.67
Verbena 'Temari Bright Pink'	JP	3.67	3.00	1.33	2.67
Verbena hybrida 'Aztec® Red'	BFP	3.33	3.00	1.33	2.56
Verbena tenuisecta 'Tapiens Pure White'	JP	4.00	2.00	1.00	2.33
Verbena 'Temari Bright Red'	JP	2.33	2.00	1.33	1.89
Vinca 'Wojo's Jem'	WG	4.00	4.67	4.67	4.44
Zinnia angustofolia 'Star Gold'	FGC	2.67	5.00	5.00	4.22
Zinnia 'Profusion Cherry'	FGC	3.67	4.67	4.00	4.11
Zinnia hybrida 'Profusion White'	FGC	3.67	4.00	4.67	4.11
Zinnia angustifolia 'Crystal White'	FGC	2.67	4.33	5.00	4.00
Zinnia elegans 'Oklahoma Formula Mix'	BS	3.67	4.00	3.67	3.78
Zinnia elegans 'Dreamland Rose'	FGC	3.67	4.33	2.67	3.56
Zinnia elegans 'Dreamland Ivory'	FGC	3.33	4.67	2.33	3.44
Zinnia elegans 'Bright Jewels Mix'	BSL	3.33	4.33	2.67	3.44
Zinnia elegans 'Dreamland Coral'	FGC	3.67	4.67	1.33	3.22
Zinnia elegans 'Dreamland Pink'	FGC	3.67	4.67	1.33	3.22
Zinnia elegans 'Dreamland Red'	FGC	3.67	4.67	1.33	3.22
Zinnia angustifolia 'Zinnita Yellow'	BS	2.67	2.67	2.67	2.67
Zinnia 'Zinnita White'	BS	2.67	2.67	2.33	2.56

Ohio State University Extension and Clark County Master Gardener volunteers would like to thank the following for their support:

Clark County Engineers, Springfield Township, Clark County Fairgrounds staff, and Clark County Commissioners, and all of the plant suppliers.

Suppliers

BFP — Ball Flora Plant
BallSd — Ball Seed Company
BS — Benary Seeds
BSL — Bodger Seeds, Ltd.
DSC — D. S. Cole Growers
FGC — Fred C. Gloeckner & Co., Inc
GS — Goldsmith Seeds
JP — Jackson & Perkins Wholesale
K — Kieft
MG — Meadow View Growers
OSUG — Ohio State University Department of Horticulture and Crop Science Greenhouses
PAS — Pan American Seed Company
PW — Proven Winners
S — Sakata Seed America, Inc.
SG — Syngenta Seeds, Inc.
TM — Thompson & Morgan
WG — Wojo's Greenhouse

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The Latest from the Midwest on *Cuphea*

Monica Kmetz-González and Claudio C. Pasian

Trials of *Cuphea* species began at The Ohio State University Learning Gardens in 2002. Interest has been increasing in recent years in new *Cuphea* to accompany the marketing of the well-known *Cuphea hyssopifolia* (false Mexican heather) and *Cuphea ignea* (cigar plant).

Our trial was designed to test new germplasm alongside *Cuphea* currently available in the industry. Our goal was to evaluate the accessions for ornamental value, either for use as is, or for possible incorporation into breeding programs at Ohio State University.

We are fortunate to be located adjacent to the Ornamental Plant Germplasm Center (OPGC). Vegetatively propagated germplasm was obtained from the OPGC in cutting form in February 2002.

Seeded accessions were obtained from the North Central Regional Plant Introduction Station (NCRPIS), USDA / ARS, Ames, Iowa, in January 2002. The majority of the industry entries were provided by Possum Run Greenhouses, Inc., Bellville, Ohio, and Timbuk Farms, Inc., Granville, Ohio.

Monica Kmetz-González, Annuals Trials Manager, The Ohio State University, Columbus, Ohio; Claudio C. Pasian, Associate Professor and Extension Specialist, Ohio State University Extension.

The 2002 Trial

The 2002 Trial began in May and continued through November. We evaluated 53 different *Cuphea* taxa comprised of 25 different species. Plants were grown in Ohio State's Horticulture and Crop Science greenhouses and outplanted in mid-May to a full-sun location in the raised-bed portion of the trial area.

Evaluations were performed on a monthly basis, with the main season evaluation occurring at the end of August. Plants were left in-ground through November to evaluate fall flowering and plant cold hardiness. The top 14 selections of 2002 were the basis of the 2003 trial, the results of which we are presenting here.

The 2003 Trial

Stock plants of the 2002 selections were overwintered in the greenhouse. Vegetative cuttings were taken on March 4 and grown to a 6" pot size. Plants were transplanted to raised beds on May 19.

Watering was provided as needed using an automatic overhead watering system. Fertilization at 200 ppm N of a 20-10-20 fertilizer was applied using Dosatron at time of transplant and then monthly until mid August. No mulch was used.

Weather

Summer 2003 was unusually cool and wet for the central Ohio area. The first month post-planting was cool and moist, and plants exhibited minimal growth. This was followed by two weeks of oppressive heat and dry conditions. The rest of the summer had cooler than average temperatures and above-average rainfall.

Evaluations

Due to the slow start, no June evaluation was performed. Subsequent evaluations took place mid-month in July, August, and September. The plants were evaluated on a 1 to 5 basis, with 1 = poor and 5 = excellent. Plants were evaluated for the following characteristics: Flower number, flower quality, foliage (plant habit and vegetative quality), and overall rating. The overall rating took all factors, including plant uniformity, into consideration. Final plant height and diameter were recorded at the end of the season in mid-September.

Results

Most of the selections re-screened this year performed in a similar manner to 2002. Table 1 lists average plant height, diameter, and plant source.

Table 2 provides the quantitative results of the evaluations performed mid-month in July, August, and September. The results are ranked in descending order based on the Overall September rating. These results, complete with photos, can also be

Table 1. Plant Source, Height, and Diameter (Feet), Ohio State 2003 *Cuphea* Species Trial.*

			Measured 9/16/03	
			No. of Ft.	Average Diameter
Cuphea Source	**Species**	**Cultivar/P.I. No.**	**Height**	
Ball Floraplant (Timbuk Farms)	x *purpurea*	Firecracker	1.3	2.6
Select Seed	*ignea*	David Verity	2.7	2.6
OPGC*	hybrid	Ames 22422	1.4	2.1
OPGC	*cyanea*	Ames 4946***	1.7	2.5
OPGC (Possum Run Grnhse.)	*hyssopifolia*	Allyson	0.6	2.1
OPGC	sp.	Ames 23677	0.6	2.7
USDA/ARS-AMES**	*varia*	Pl 607939	1.2	1.4
OPGC	hybrid	Ames 22423	1.5	2.6
OPGC (Possum Run Grnhse.)	*ignea*		0.8	1.5
Ball Floraplant (Timbuk Farms)	hybrida	Purple Trailing	0.7	1.9
OPGC	hybrid	Ames 22287^Starfire	2.5	2.7
OPGC	*micropetala*	Ames 26109	3.1	3.0
OPGC	x *purpurea*	Ames 26110 Georgia Scarlet	1.5	1.9
USDA/ARS-Ames**	*palustris*	Ames 17817	0.9	3.3

* OPGC — Ornamental Plant Germplasm Center, Columbus, Ohio
** USDA/ARS, NCRPIS — North Central Regional Plant Introduction Station, Ames, Iowa
*** Two died.

Table 2. Ohio State 2003 *Cuphea* Species Trial*

Evaluation Results		Rating 1- 5 scale (1 = poor, 5 = excellent)					
		JULY**	**AUG.****	**SEPT.**			
		July 17	**Aug 14**	**Sept 18**	**Sept 18**	**Sept 18**	**Sept 18**
Cuphea Species	**Cultivar/P.I. No.**	**Overall**	**Overall**	**Flower No.**	**Flower Quality**	**Foliage**	**Overall**
x *purpurea*	Firecracker	3.8	4.3	4.5	5.0	4.0	4.8
ignea	David Verity	5.0	5.0	4.3	4.0	4.3	4.4
hybrid	Ames 22422	2.8	3.5	3.8	4.0	3.0	3.8
cyanea	Ames 4946	3.8	3.5	3.0	3.5	2.5	3.3
hyssopifolia	Allyson	4.5	4.5	2.5	2.8	4.5	3.0
sp.	Ames 23677	4.5	4.3	3.0	2.8	3.3	3.0
varia	Pl 607939	4.5	4.0	3.0	2.0	3.0	3.0
hybrid	Ames 22423	2.8	3.5	3.5	3.8	2.5	3.0
ignea		3.3	4.0	2.0	3.0	2.8	2.8
hybrid	Purple Trailing	3.3	3.0	2.0	3.3	3.8	2.8
hybrid	Ames 22287 Starfire	3.8	4.0	2.0	2.5	3.0	2.5
micropetala	Ames 26109	4.3	3.5	2.0	3.0	2.8	2.5
x *purpurea*	Ames 26110 Georgia Scarlet	3.8	3.0	3.8	3.5	2.0	2.5
palustris	Ames 17817	2.8	2.5	1.8	2.8	2.8	2.5

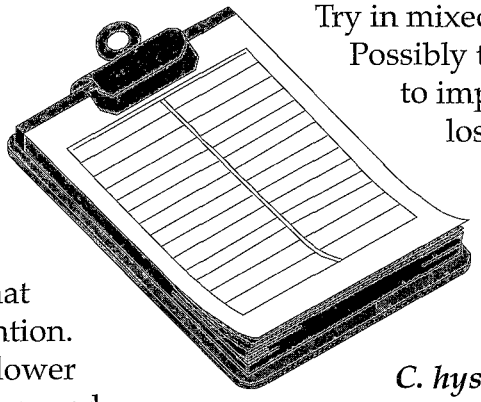
* Table ranked in descending order of Overall rating Sept 18.
** Flower number, flower quality, and foliage ratings for July and August can be accessed on the Web at: http://floriculture.osu.edu

accessed on our web site at Results which shows all of our other cultivar trials as well. The web address is:

http://floriculture.osu.edu.

Here are some qualitative descriptors of the accessions, with the accessions listed in descending order based on the September 2003 Overall rating.

Cuphea x *purpurea* 'Firecracker'



"Wow!!" was the immediate response when one member of our evaluation team looked at these flowers. This is one that really attracts people's attention. Beautiful, bright/brilliant flower color — purple with deep rose-red. Flowers are borne on one side of the stem and at tips. Flowered well all season, and numbers increased even more in late summer to fall. Nice for hanging baskets and containers or at the edge of raised beds. Currently available in the industry, from Ball Floraplant.

C. ignea 'David Verity'

Nice! A solid performer. This is just a great plant. Consistent scarlet/orange flowers are a bit larger in size and number than the typical "cigar plant." Dark green foliage. Is taller as well; an upright shrub 2-1/2 to 3 feet tall. Works well in containers as well. This is usually listed as *C. ignea,* but is actually a cross between *C. ignea* and *C. micropetala.* Currently available in the industry. We obtained these as rooted plants from Select Seeds.

C. hybrid Ames 22422.

Nice flowers — deep rose-red petals with purple interior and tube. Flowering continues late in the season. Mounds to 2 feet.

C. cyanea Ames 4946

Unique flower — pink tubes, yellow at ends, with two maroon petals and protruding red stamens. Nice red-pink pubescence on stems and leaf petioles. Nice contrast. Vegetatively can be gangly. Try in mixed containers as taller plant. Possibly try plant growth regulators to improve habit. Watch — we lost a few trial plants to disease as well. The only *Cuphea* in this year's trial to suffer any mortality. Breeding potential.

C. hyssopifolia 'Allyson'

One of the most common *Cuphea* currently on the market, this Mexican heather has been a good performer in four straight years of annual trials here at Ohio State. This purple-flowering "contained shrub" is an excellent form for borders, containers, etc. Flower number does fluctuate throughout the season, and flower numbers were low at the September rating time this year. The nice texture and habit compensate for the flower-number valleys. Currently available in the industry.

C. sp. Ames 23677

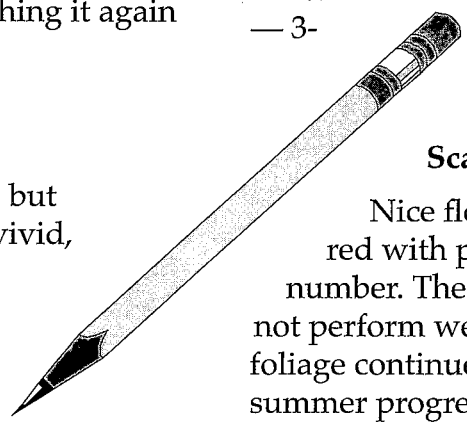
A new accession with possibilities. Small but abundant light purple flowers develop consistently throughout the season. Nice spreading low grower, lending itself to multiple uses — containers, hanging baskets, edges of raised beds, and even as a ground cover. In containers, keep feed consistent to maintain better foliage color. Otherwise, this plant requires virtually no maintenance.

C. varia PI 607939

Nicely contrasting flowers and foliage; delicate soft lilac flowers against blue-gray-green foliage. Nice texture — wispy. Upright, controlled habit, lends itself to usefulness in containers by providing a bit of height. Does well as in-ground, too. Does self-seed quite a bit. Of particular note: this was the most cold hardy of all *Cuphea* studied here in 2002. It survived the first few hard freezes we had last November. We will be watching it again this year.

C. hybrid Ames 22423

Very similar to Ames 22422, but flower color is not quite as vivid, and foliage struggles more. Foliage color can appear washed out.



C. ignea

"Cigar plant." The species type widely available on the market, with bright orange tubular flowers darkly tipped. Nice compact habit. Flower numbers were a bit low in the trial here this year. Currently available in the industry.

C. hybrid 'Purple Trailing'

Spreads well, but flower numbers were very low until late summer to fall. Somewhat diminutive flowers are a deep purple and attractive. Lends itself to hanging basket, container use. Currently available in the industry.

C. hybrid Ames 22287 'Starfire'

Released as a hybrid by the USDA in 1995. It is a cross between *C. ignea* and *C. angustifolia.* Flower best described as a pink "cigar plant" flower. Good tough plant that can be used in containers as well as in-ground. This year flower numbers were not high enough to balance out the vegetative growth. Flower numbers were better in 2002. A bee magnet.

C. micropetala Ames 26109

Upright "shrub" with beautiful glossy foliage. Flower tubes are in shades of orange to yellow, few in number main season, but increased in late season. In last year's trial, most flowers occurred in October. Has potential. Is taller — 3- 1/2 to 4 feet.

C. x purpurea 'Georgia Scarlet'

Nice flowers — deep pinkish-red with purple and good flower number. The vegetative portion did not perform well again here this year; the foliage continues to go downhill as the summer progresses. Currently available in the industry.

C. palustris Ames 17817

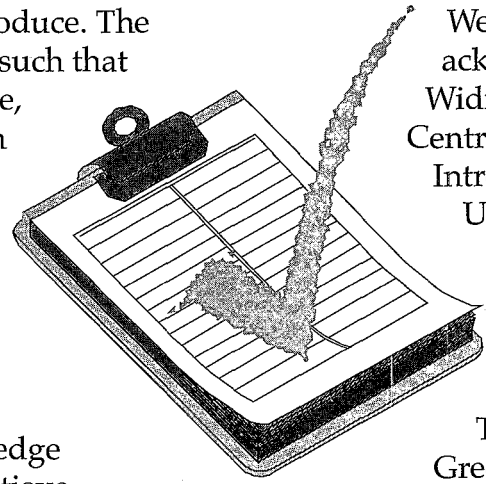
Can function as a groundcover! Very vigorous vegetatively. Flowering is almost exclusively in September and October, with a very low number of small white/lilac flowers during the main season. In last year's trial, very profuse flowering commenced in October, producing a carpet of flowers, which was quite beautiful.

Final Comments

In the last 10 to 15 years, we have witnessed the advent of numerous new floriculture crops in the market. This tendency towards the new and different has not slowed down, and we expect this trend to continue.

In the hands of a good breeder (or breeding program), *Cuphea* may become an important component of the crop

mix that many growers produce. The variability of this genus is such that some day in the near future, we may see *Cuphea* used in hanging baskets, mixed containers, as bedding plants, or as ground covers.



Acknowledgments

We would like to acknowledge Dr. David Tay and Susan Stieve of the Ornamental Plant Germplasm Center (OPGC) for providing vegetative germplasm and resource information, as well as for their help in the main season evaluations both years. Further information on the OPGC can be accessed at:
http://www.opgc.osu.edu/.

We would like to acknowledge Dr. Mark Widrlechner of the North Central Regional Plant Introduction Station (NCRPIS), USDA/ARS, Iowa State University, Ames, Iowa, for providing seed germplasm and resource information.

Thanks to Possum Run Greenhouses, Inc., Bellville, Ohio, and Timbuk Farms, Inc., Granville, Ohio, for providing some of the industry entries.

Thanks also to Dr. Richard Criley of the University of Hawaii and Dr. Peter Konjoian for their assistance in the main season/final selection evaluation in 2002.

Finally, a big thank you to our Annuals Team of Master Gardeners, who helped in all phases of this trial.

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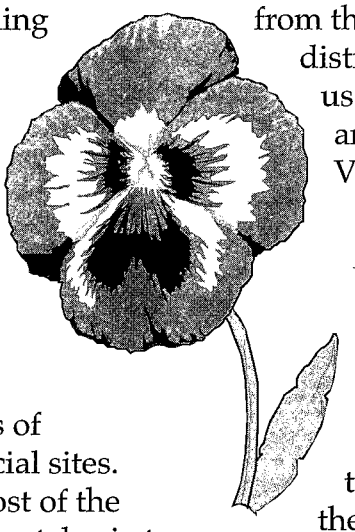
Ohio State 2002-2003 Fall Pansy - Viola Trial Results

Monica Kmetz-González and Claudio C. Pasian

Trial Site Location

This trial marked the third year for our Fall Pansy and Viola Trials, and the first year it was conducted in-ground. This new site is located in the Learning Gardens area just north and west of our departmental buildings on The Ohio State University's Columbus campus. Our previous trials had been conducted in raised beds.



We believe our new in-ground site more directly mimics the "real world" growing areas of homeowner, city, and commercial sites. The trial site receives shade most of the morning, followed by approximately six to eight hours of full sun. The area, formerly in grass, was amended with Kurtz Brothers Professional Blend. Pre-plant fertilization with 300 ppm N 20-10-20 was performed by means of liquid feed on August 27 and September 9, 2002.

Plant Material

A total of 83 cultivars were evaluated. Of these, 63 were Pansy (including six Panola) and 20 were Viola. Seed from the participating breeders and distributors was grown again for us by Bob Barnitz of Bob's Market and Greenhouse, Mason, West Virginia.

Procedure

Plants in 2-1/4" cell paks were received in our greenhouses on Sept. 11, 2002. On Sept. 12, a Rootshield drench was applied to the plants. Transplanting to the in-ground site occurred on Sept. 17. Nine plants per cultivar were outplanted. Spacing was on 1-foot centers. No mulch was used. Post-planting fertilization with 200 ppm N 20-10-20 with a Dosatron occurred on Sept. 25, Oct. 9, and Oct. 21. There were no pest or disease problems.

Weather Conditions

The cold temperatures during the course of this trial provided a good test of overwintering. Minimum and maximum temperatures from mid-

Monica Kmetz-González, Annuals Trials Manager, The Ohio State University, Columbus, Ohio; Claudio C. Pasian, Associate Professor and Extension Specialist, Ohio State University Extension.

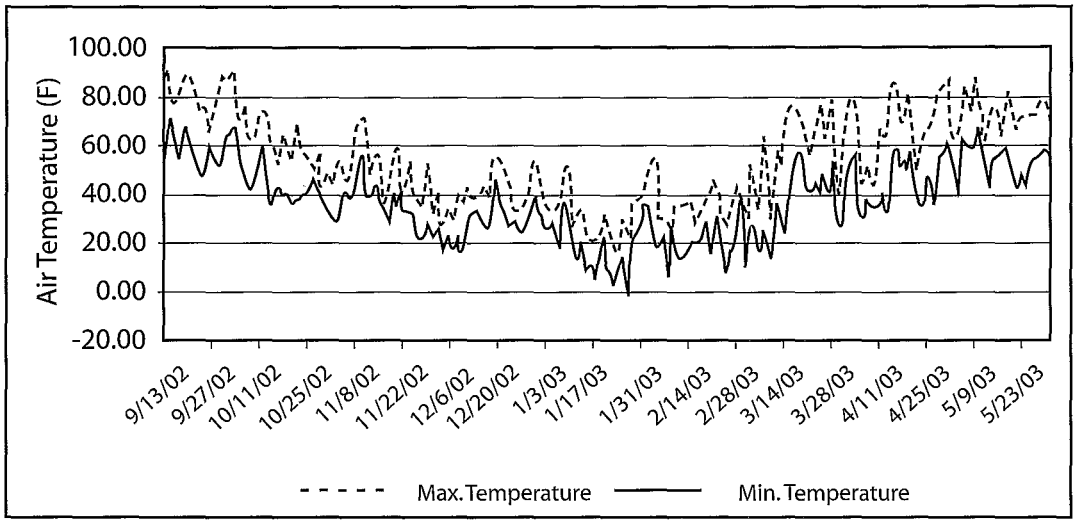


Figure 1. Minimum and maximum temperatures during trial period September 2002 - May 2003.

September through mid-May can be found in Figure 1. These temperatures were recorded by a departmental weather station located in close proximity to the trial plot.

Plants got off to a good growing start with favorable climatic conditions in September and October. The first night of freezing temperatures occurred on Nov. 1. The plants overall looked good until the first very hard freezes occurred at the end of November.

The winter was punctuated by cold temperatures and some snowfall throughout. The season low of -2°F occurred on Feb. 1. A major snowstorm on Feb. 16 covered the area with 18 inches of snow, and snow cover remained on the trial plants for the next three weeks before any melting occurred.

This snow cover was somewhat helpful in insulating the plants from the continuing cold temperatures over the next month. The first warming trend took place in mid-March, and favorable spring weather conditions followed.

Evaluations and Results

Ratings were based on a scale of 1 to 5, with 1 = poor and 5 = excellent. Plants were evaluated for the following characteristics:

Flower Quality

Aesthetics, color, health, and appearance

Flower Number

1 = Low, 5 = Very floriferous

Foliage

Vegetative vigor, aesthetics/color, health, and appearance

Uniformity

1 = Quality is variable from plant to plant.
5 = Quality is similar between all plants (for Spring evaluation only).

Overall

Overall rating for all plants in the grouping, taking all aspects into consideration.

Quantitative evaluation results can be found in the accompanying tables.

The Fall Evaluation (Pansies, Table 1, and Violas, Table 2) was performed six weeks after transplant by the Annual Trials Coordinator. Overwintering evaluations were done on March 17, March 24, and April 14.

A final winter survival count was performed on April 23, with the total overwintering survival count for the trial being 94.4%. Specific cultivar survival percentages can be accessed in additional tables on the Web at:

http://floriculture.osu.edu/archive/aug03/PansyViola03Trial.html

The final Spring Evaluation (Pansies, Table 3, and Violas, Table 4) was done by our core team of evaluators on May 1. Plants were pulled on May 12 to make way for our Summer Annuals Trial.

The top performers in the final Spring Evaluation are listed here. These are the best selections after overwintering. Of note, many other cultivars performed well in the trial.

Pansies: Top 12

Ultima Baron Merlot (perfect score in every category)
Panola Purple w/Face
Panola Blue w/Blotch Improved
Ultima Baron Purple (Perfection)
Skyline Blue w/Face
Panola White w/Blotch
Panola Beaconsfield
Ultima Impressions Blue Shades
Fama Silver Blue
Ultima Beacon Blue
Panola Golden Yellow
Clear Sky Purple.

Violas: Top 5

Penny Yellow Jump-Up and Penny Violet Flare (both with perfect scores in every category)
Sorbet Yellow Frost
Sorbet Sunny Royale
Sorbet Coconut Swirl.

All results, along with individual cultivar photos and overview photos of the trial site, can be accessed on the Web at:

http://floriculture.osu.edu/archive/aug03/PansyViola03Trial.html

Acknowledgments

We would like to acknowledge the help of our Annuals Team of Master Gardeners who helped in all phases of this trial.

We thank Bob Barnitz of Bob's Market and Greenhouse, Mason, West Virginia, for seeding and growing the transplants.

And we thank the following companies for their participation in this year's trial:

Benary
Goldsmith Seeds
PanAmerican Seeds
Sakata, Syngenta, and Takii.

Table 1. Ohio State Fall Pansy and Viola Trial, 2002-03. Fall Rating 10/22/02.						
Pansies		Seed Company	Rating Scale: 1: Poor - 5: Excellent			
Series	Cultivar		Flower Appear-ance	Flower Number	Vegetative Growth/ Foliage	Overall*
Delta	PRM Deep Blue w/Blotch	Syngenta	4.75	4	3	4.25
Panola	Blue w/Blotch Improved	PanAmerican	4.75	4	3.75	4
Panola	Purple w/Face	PanAmerican	4.5	3.75	3.5	4
Ultima Beacon	Blue	Sakata	4.5	3.5	3	4
Fama	Spanish Eyes	Benary	4.25	3	4	4
Ultima Baron	Merlot	Sakata	3.75	3.75	4	3.75
Panola	Beaconsfield	PanAmerican	5	2.5	3.5	3.5
Ultima Impressions	Rose Shades	Sakata	3.75	3	3.25	3.5
Panola	Yellow w/Blotch	PanAmerican	3.25	3.75	3.25	3.5
Iona	Ocean	Takii	4	2.5	2.75	3.25
Clear Sky	Sky Purple	Syngenta	4	2.25	4	3.25
Ultima Impressions	Blue Shades	Sakata	3.75	3.25	3	3.25
Karma	Yellow	Goldsmith	3	2.5	3.75	3.25
Fama	Dark-Eyed Blue Improved	Benary	4.25	3	2.5	3
Karma	White Blotch	Goldsmith	3.75	3	2.75	3
Ultima Baron	Purple (Perfection)	Sakata	3.75	2.75	3.75	3
Panola	Golden Yellow	PanAmerican	3	3	4	3
Delta	PRM Yellow w/Blotch	Syngenta	3	3	3	3
Karma	Rose Blotch	Goldsmith	3	2.75	2.75	3
Iona	Purple & White w/Blotch	Takii	4.75	2.75	2.5	2.75
Karma	Blue Blotch	Goldsmith	4	2.5	2	2.75
Panola	White w/ Blotch	PanAmerican	3.75	2.75	2.75	2.75
Delta	Violet w/ Face	Syngenta	3.75	2	3.25	2.75
Delta	White w/ Blotch Improved	Syngenta	3.5	3	2.5	2.75
Fama	Carmine Rose w/Blotch	Benary	3.5	3	2.5	2.75
Iona	Purple & Yellow w/Blotch	Takii	3.25	2.5	2.5	2.75
Fama	Dark-Eyed Lemon	Benary	3.25	2	2.5	2.75
Iona	White w/Blotch	Takii	3	3	2.75	2.75
Iona	Yellow	Takii	3	3	1.5	2.75
Ultima Beacon	Rose	Sakata	4	2.5	2.25	2.5
Iona	Purple w/Blotch	Takii	4	2	2.25	2.5
Fama	Purple	Benary	4	1.5	2.75	2.5
Iona	Frosty Lemon	Takii	3.25	2.75	2.5	2.5
Fama	True Blue	Benary	3.25	1.75	2.75	2.5
Fama	White Exp.	Benary	3	3	2.5	2.5
Fama	Peach Shades Exp.	Benary	3	2.75	2	2.5
Karma	Red Blotch	Goldsmith	3	2.5	2.75	2.5

Table 1 (continued). Ohio State Fall Pansy and Viola Trial, 2002-03. Fall Rating 10/22/02.						
Pansies		Seed Company	Rating Scale: 1: Poor - 5: Excellent			
Series	Cultivar		Flower Appear-ance	Flower Number	Vegetative Growth/ Foliage	Overall*
Skyline	Copperfield	Syngenta	3	2.5	2.5	2.5
Ultima Baron	Red Blotch (Red Perfection)	Sakata	3	2.5	2.5	2.5
Ultima Beacon	Yellow	Sakata	3	2	3	2.5
Delta	PRM PU White (Pure White)	Syngenta	2.75	2.5	2.5	2.5
Clear Sky	Deep Orange	Syngenta	2.75	2.25	2.5	2.5
Iona	Rose w/Blotch	Takii	4.5	2.25	1.75	2.25
Ultima Baron	Mahogany	Sakata	3	2	2.75	2.25
Colossus	White w/Blotch	Syngenta	3	2	2.25	2.25
Iona	Gold w/Blotch (Golden w/Blotch)	Takii	2.75	2.25	2.25	2.25
Colossus	Deep Blue w/Blotch	Syngenta	4	1.5	2.25	2
Colossus	Rose w/Blotch	Syngenta	3.5	2	1	2
Ultima Morpho		Sakata	3.5	1.5	2.75	2
Colossus	Red w/Blotch Improved	Syngenta	2.75	2	2.75	2
Karma	Yellow Blotch	Goldsmith	2.75	2	1.5	2
Delta	PRM PU Yellow (Pure Yellow)	Syngenta	2.75	1.5	2.5	2
Fama	Silver Blue Exp.	Benary	2.75	1.5	2	2
Colossus	Yellow w/Blotch	Syngenta	2.5	2	2	2
Karma	Rose	Goldsmith	3	2.75	2	1.75
Fama	Lemon Blotch Exp.	Benary	3	1.75	2	1.75
Fama	Dark-Eyed Yellow	Benary	2.25	1	1.75	1.75
Fama	Primrose	Benary	3	1.75	2	1.5
Ultima Impressions	Yellow Shades	Sakata	3	1.25	2	1.5
Skyline	Blue w/Face	Syngenta	3	1	3	1.5
Fama	Silver Blue	Benary	3	0.5	3	1.5
Fama	Red	Benary	2.75	1	2.5	1.25
Fama	Pure White	Benary	2.5	2.25	1.5	1
* Table ranked in descending order based on the Overall rating.						

Table 2. Ohio State Fall Pansy and Viola Trial, 2002-03. Fall Rating 10/22/02.						
Violas		Seed Company	Rating Scale: 1: Poor - 5: Excellent			
Series	Cultivar		Flower Appear-ance	Flower Number	Vegetative Growth/ Foliage	Overall*
Penny	Yellow Jump-Up	Goldsmith	4.75	3.5	4.5	4
Sorbet	Orange Duet	PanAmerican	4	3.25	4	3.75
Starlet	Pink Shades	Takii	3.75	4	3.75	3.75
Penny	Violet Flare	Goldsmith	4.5	3	3.25	3.5
Sorbet	Coconut Swirl	PanAmerican	4.25	4	3.5	3.5
Starlet	Light Rose w/Blotch	Takii	4.5	4.25	4	3.25
Penny	Deep Blue	Goldsmith	4.5	3.5	3.25	3
BabyFace	Ruby Gold	PanAmerican	4	3.25	3	3
Sorbet	Yellow Frost	PanAmerican	4	2.25	4.25	3
Starlet	Red w/Blotch	Takii	3.75	2.25	3.5	3
BabyFace	Marina	PanAmerican	4	3.25	2	2.75
Sorbet	Sunny Royale	PanAmerican	4	2	3.75	2.75
Starlet	Yellow	Takii	3.75	3.25	2.75	2.75
Sorbet	Blueberry Cream	PanAmerican	3.75	2.5	2.75	2.75
Sorbet	Yellow Delight	PanAmerican	3.5	3	3.75	2.75
Penny	Orange	Goldsmith	3	3	3	2.75
Starlet	Orange	Takii	3	2.75	3.25	2.75
Penny	Orange Jump-Up	Goldsmith	3.5	3	2	2
Penny	Yellow	Goldsmith	3.5	2.75	2	1.75
Penny	White	Goldsmith	2.5	3	2	1.5
* Table ranked in descending order based on the Overall rating.						

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Results of Annual Plant Trial Gardens at the Cincinnati Zoo and Botanical Garden and the Cincinnati Parks Department, Krohn Conservatory: 2003

David E. Dyke

The Ohio State University Extension Horticulture Program in Hamilton County, the Cincinnati Zoo and Botanical Garden (CZABG), the Cincinnati Flower Growers Association (CFGA), the Krohn Conservatory, and the OSU Master Gardener Program in Hamilton County collaborated to establish demonstration/trial gardens at the Cincinnati Zoo and Botanical Garden and Cincinnati Parks Department/Krohn Conservatory in the spring of 2003. This was the second year of these collaborative trials at the CZABG and the first at the Krohn Conservatory.

The gardens at the CZABG were designed by Steve Foltz, Horticultural Director, CZABG, and Dave Roberts, Horticulturist, CZABG.

Participating seed companies were Pan American Seed Co., Ball Floral, S&G Flowers, Sakata Seed, and Proven Winners. Those companies provided plugs or seeds and funds or chemicals/supplies to compensate members of the CFGA for growing the plants. Ball Floral was the exception, providing finished plants. Additional sponsors were Eason Horticultural Resources and Wetsel, Inc.

Members of the CFGA donated a large number of plants in addition to those they grew for the seed companies specifically for the trials. More than 20,000 plants were planted for the project.

Three goals were set for the gardens at the CZABG.

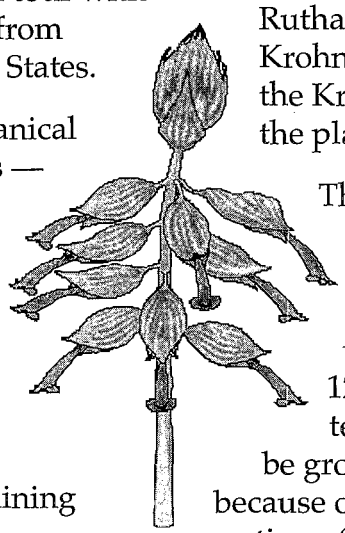
- To evaluate annuals on the basis of quality and performance as seen in the late summer in order to determine which could be recommended for planting in area gardens.
- To provide the general public and commercial growers/landscapers an opportunity to observe many varieties of the latest, yet fairly well-proven, annuals available that were professionally grown in attractive garden settings (including in planters).
- To promote those annuals that performed well enough to be recommended for planting in area gardens.

David E. Dyke, Commercial Floriculture Agent, Ohio State University Extension, Hamilton County.

Events and activities conducted to meet the second and third goals included:

1. Tours of the gardens conducted by the CZABG staff for visitors to the Zoo:
    - International Master Gardener's Conference — 1,200 people
    - Cincinnati State Horticulture Classes
    - University of Cincinnati Horticulture Classes
    - Ohio Nursery and Landscape Association Plant Selection Committee
    - Garden Clubs in the area, including the annual meeting of the Federated Garden Clubs, which includes 100 members from more than 50 garden clubs in the area.
    - American Nursery and Landscape Association summer field tour with more than 100 attendees from across the eastern United States.
    - Groups from visiting Botanical Gardens and Arboretums — Bernheim, Holden, Morton, Cox, Wegerzyn, Fairchild Tropical Gardens, and many others.
    - OSU Master Gardener Program, Hamilton County, annual plants training was held at the Zoo.
    - Ohio's First Lady Hope Taft toured the gardens.
    - Cincinnati Flower Growers Association members held their monthly meeting, toured, and actively participated in the trial process.
2. Other media relations:
    - 10,000 Annual Plants brochures were printed and distributed throughout the greater Cincinnati community at horticultural events, classes, and tours related to the gardens.
    - Annual Plants brochures were included in Zoo press kits sent out to more than 500 media outlets during the Zoo Blooms event in April/May.
    - Press releases were sent out to media about the Annual Trials Program in August.
    - The CZABG participated in the Cincinnati Home and Garden Show to promote the program.

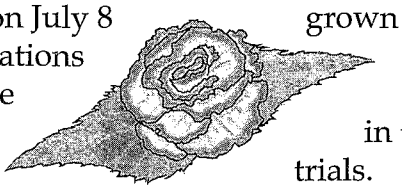
The gardens (Hinkle Gardens) at the Krohn Conservatory were developed in cooperation with Andrea Schepmann and Ruthanne Spears, management at the Krohn. Vicki Schumacker, florist at the Krohn, designed and supervised the planting of the gardens.



The goal of those gardens was to determine the amount of maintenance required for each of the plants being tested at the CZABG. Initially, 12 of each of the plants being tested at the CZABG were to be grown at the Krohn. However, because of space limitations, only a portion of those were actually grown.

Plants at the CZABG were planted in the ground in beds that were tilled with minimal compost added. All of the more than 102 varieties in the trials were labeled for easy identification for the 1.2 million visitors to the Zoo in 2003.

Plants were evaluated by members of the organizations involved in the trials — seed companies, the CFGA, the CZABG, and Ohio State University Extension, Hamilton County, on July 8 and August 20. Separate evaluations were conducted by horticulture volunteers, Master Gardeners, and members of local garden clubs on August 20, September 4, and September 11.



Both groups evaluated plants on a scale from 1 to 5 in which 1 = poor, 3 = fair, and 5 = excellent. Plants were rated on overall appearance. Factors that were considered included plant health (including insect and disease damage), color, and vigor. Plants that looked poor were taken off the evaluation list.

Several growing problems were encountered during these trials. The early summer was extremely wet and cool. The rest of the summer was extremely wet (on two occasions more than eight inches of rain was recorded in a 48-hour period).

Some of the beds were new and had poor soil and/or drainage. Some other quite unusual growing challenges were also encountered. These included peacocks, ducks, and rabbits walking through the beds and/or eating plants and 1.2 million people walking by!

Therefore, some plants in the trial that did not make the recommended list may be quite good for the area but were removed from the trials due to one or more of the problems listed previously.

The Top Picks of 2003 are listed in Table 1. Other plants also recommended for area gardens are listed in Table 2. Some of the plants listed as Top Picks 2002 were also grown in 2003. However, once a plant has attained Top Pick status, it is no longer listed in the results of subsequent trials.

The results of the trials at the Krohn Conservatory are provided in Table 3. All plants in the gardens were maintained and evaluated by Mike Grawe, a volunteer at the CZABG. All plants were evaluated for deadheading and pinching/cutback on June 27 and August 13 using the scoring system shown here.

Score	Plant Maintenance Needed
1	Low
2	Low to Medium
3	Medium
4	Medium to High
5	High

Grawe assessed the maintenance requirements from the viewpoint of a backyard gardener. No plant was observed to have a significant problem with an insect infestation or disease.

New trial gardens of both annuals and grasses are planned for 2004. For more information, contact Steve Foltz at the Cincinnati Zoo and Botanical Garden, Horticulture Department, at 513-475-6106 or Dave Dyke at 513-505-1202.

2003 Annuals

Table 1. Top Picks 2003 for Cincinnati Zoo Botanic Gardens				
Plant Name	**Light Preference**	**Habit/ Size**	**Flower Color**	**Foliage Color**
'Artist' Blue Ageratum	sun	groundcover/5"	light blue	
'Artist' Purple Ageratum	sun	groundcover/5"	dark purple	
'Purple Knight' Joseph's Coat	sun/part shade	upright clump/ 30"	NA	glossy maroon
'Angelface' Blue Angelonia	sun/part shade	erect/24"	blue/white	
'Angelmis' Lavender Angelonia	part shade	upright	lavender/white	
'Bengal Tiger' Canna	sun	erect/5'-6'	orange	green/yellow striped
'Tropicana' Canna	sun	erect		
'SunStorm' Bright Red Vinca	sun	mounding clump/12"	bright fushia	
'Jet Black Wonder' Elephant Ear	sun/part shade		NA	dark chocolate macroon
'Patriot' Cherry Lantana	sun/part shade	mounding	red/yellow	
'Lucky' Yellow Lantana	sun/part shade	mounding/15"	clear yellow	
'Lemon Cream 'Lantana	sun/part shade	mounding/15"	light yellow	
'Patriot Desert Sunset' Lantana	sun	mounding	red	
'Dark Star' Coleus	sun/part shade	upright mound		dark maroon
'Sedona' Coleus	sun/part shade	mounding/24"		brick orange/rust
'Life Lime' Coleus	sun/part shade	mounding		lime
'Dipt in Wine' Coleus	sun/part shade	mounding		yellow edge/ bright red center
'Chocolate Drop' Coleus	sun/part shade	mounding		green edge/chocolate center
'Strawberry Drop' Coleus	sun/part shade	mounding		
'Black Heart' Sweet Potato Vine	sun/part shade	trailing groundcover	dark chocolate	
'Summer Wave Blue' Wishbone Flower	part shade/shade	groundcover/6"	blue/white throat	
'Summer Wave Large' Violet Wishbone Flower	sun/shade	groundcover	purple	
'Summer Wave Amethyst' Wishbone Flower	sun/shade	groundcover		
'Prairie Sun' Black-Eyed Susan	sun	upright clump	bright yellow	
'Superbena' Burgundy Verbena	sun	groundcover	bright purple	
'Crystal White' Zinnia	sun	mounding	white	
'Explorer Coral' Petunia	sun	mounding groundcover		
'Profusion Orange' Zinna	sun	groundcover/10"	bright orange	
Best of 2002				
'Dragon Wing Pink' Begonia	part shade	mounding/2'	pink-dark pink	glossy green
'Dragon Wing' Begonia	part shade	mounding/2'	dark pink-red pink	glossy green
'Australia' Canna	sun/part shade	upright/erect/4'	red burgundy	
'Marguerite' Sweet Potato Vine	sun/part shade	trailing groundcover	lime	
'Ingelsheim' Lantana	sun		orange/yellow/ pink	
'New Gold' Lantana	sun	groundcover/4"	yellow	

Table 1 (contined). Top Picks 2003 for Cincinnati Zoo Botanic Gardens				
Best of 2002 (continued)				
Plant Name	**Light Preference**	**Habit/ Size**	**Flower Color**	**Foliage Color**
Purple Fountain Grass	sun	erect	purple	
'Tidal Wave Silver' Petunia	sun	groundcover/10"		light lavender
'Kingwood Torch' Coleus	part shade	upright mound2'-2.5'		red/burgundy
Persian Shield	sun/part shade	mounding/24"-30"	purple, lavender, green	
'Star Gold' Zinnia				

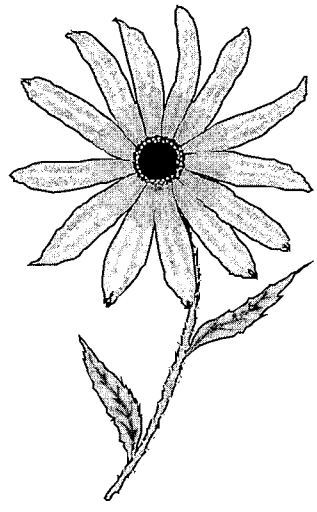


Table 2. Additional Annuals of Note in 2003 Trials at Cincinnati Zoo and Botanic Gardens.				
Plant Name	**Light Preference**	**Habit/ Size**	**Flower Color**	**Foliage Color**
'Redthreads' Joseph's Coat	part shade	mounding/8"	deep maroon/ burgundy	
'Escargot' Begonia	part shade/shade	mounding clump (good container plant)	burgundy w/ silver snail-like swirl	
'Superbells White' Million Bells				
'Black Knight' Canna	sun	erect/5'		
'Australia' Canna	sun			
'Chilly' Chili Pepper	sun/part shade	clump	fruits red, yellow, orange	
'Cajun Red' Impatiens	part shade/shade		red	
'Patriot' Parason Lantana	sun	mounding		
'Patriot' Dove Wings Lantana	sun	mounding	white	
'Patriot' Weeper Sunbeam Lantana	sun	mounding	yellow	
'Carlos' Lantana	sun	mounding		
'Lucky' Peach Sunrise Lantana	sun	mounding		
'Florever' Salmon Geranium	sun	upright clump	salmon-pink	
'Florever' Red Geranium	sun	upright clump	red	
'Florever' Deep Rose Geranium	sun	upright clump	deep rose	
'Deep Orchid' Vinca	sun/part shade	mounding		
Fountain Grass	sun	erect		
'Explorer Coral' Petunia	sun	mounding groundcover		
'New Wonder' Scaevola	sun	groundcover	purple	
Freckles Coleus	sun/part shade	mounding		yellow edge/rust-orange center
'Sky Fire' Coleus	sun/part shade	mounding		yellow edge/strawberry center
'Saturn' Coleus	sun/part shade	mounding		
New Zealand Flax (Phormium tenax)		great container plant		
'Chili' Chili Pepper	sun	mounding (did well in a wide variety of soil/moisture conditions)		
'Superbena' Blue Purple Verbena	sun	groundcover		
'Superbena' Large Lilac Blue Verbena	sun	groundcover		
'Butterfly Light' Lavender Starflower (Pentas)	sun	mounding		
'Miracle Mix' Impatiens	part shade/shade			
Purple Heart (Setcreasea pallida)				
'Blackie' Sweet Potato Vine	sun/part shade	trailing groundcover		
Palm Grass (Setaria palmifolia)				
'Crystal White' Zinnia	sun	mounding	white	

Table 3. Maintenance Requirements of Annuals Grown in the Krohn Conservatory Trials, 2003.

Date: 6/27/03	Site: Hinkle Garden		
Plant	Dead-heading	Pinching/ Cutback	Comments
Caliabrachoa Superbells Blue	1	1	
Caliabrachoa Superbells Coral Pink	2	1	
Caliabrachoa Superbells Red	2	1	
Caliabrachoa Superbells Trailing Pink	5	1	Many Yellowed Leaves
Caliabrachoa Superbells White	2	1	
Coleus Chocolate Drop	1	1	
Coleus Dipt in Wine	1	1	
Diascia Flying Colors Coral	1	1	
Geranium Florever Deep Rose	5	1	
Geranium Florever Red	5	1	Some Yellowed Leaves
Lantana Patriot Cherry Classic	1	2	
Lantana Patriot Dove Wing	1	1	
Lantana Patriot Parasol Camara	1	1	
Lantana Patriot Weeper Sunstream	1	1	
Osteospermum Symphony Peach	1	1	
Osteospermum Symphony Vanilla	3	1	
Pentas Butterfly Blush	1	1	
Pentas Butterfly Light Lavendar	1	1	
Petunia Easy Wave Cherry	4	1	Some Yellowed Leaves
Petunia Easy Wave Shell	2	1	
Petunia Explorer Coral	3	1	
Petunia Explorer Magenta	3	1	
Petunia Explorer Pink	3	1	
Petunia Kahuna Violet	5	1	
Petunia Kahuna Whiite	1	1	
Petunia Magenta	2	1	
Petunia Misty Lilac	1	1	
Petunia Rose Pink	2	1	
Petunia Spreading Explorer Blue	2	3	
Petunia Supertunia White	2	1	
Petunia Supertunias Giant Pink	2	2	
Petunia Wave Pink	2	1	
Salvia Salvador Red	3	2	
Verbena Silver Magic	1	1	
Verbena Superbena Blue Purple	1	1	
Verbena Superbena Burgundy	1	2	
Verbena Superbena Pink Shades	1	1	
Verbena Tukana White	1	1	
Vinca Radiant Rose Mix	1	1	

Table 3 (continued). Maintenance Requirements of Annuals Grown in the Krohn Conservatory Trials, 2003.

Date: 8/13/03	Site: Hinkle Garden		
Plant	**Dead-heading**	**Pinching/ Cutback**	**Comments**
Ageratum Artist Blue	1	3	
Ageratum Artist Purple	1	3	
Caliabrachoa Superbells Blue	1	1	
Caliabrachoa Superbells Coral Pink	3	2	
Caliabrachoa Superbells Red	2	2	
Caliabrachoa Superbells Trailing Pink	3	1	Many Yellowed Leaves
Caliabrachoa Superbells White	1	2	
Coleus Aurora Sherbet	1	4	
Coleus Chocolate Drop	1	4	
Coleus Dark Star	1	3	
Coleus Dipt in Wine	1	3	
Coleus Lifelime	1	2	
Diascia Flying Colors Coral	1	2	
Geranium Florever Deep Rose	3	1	
Geranium Florever Red	3	1	Some Yellowed Leaves
Lantana Patriot Cherry Classic	1	3	
Lantana Patriot Dove Wing	1	3	
Lantana Patriot Parasol Camara	N/A	N/A	Dead
Lantana Patriot Weeper Sunstream	1	2	
Osteospermum Symphony Lemon	2	1	
Osteospermum Symphony Peach	N/A	N/A	Dead
Osteospermum Symphony Vanilla	N/A	N/A	Dead
Pentas Butterfly Blush	1	1	
Pentas Butterfly Light Lavendar	1	1	
Pepper Chilly Chili	1	1	
Petunia Easy Wave Cherry	3	3	Some Yellowed Leaves
Petunia Easy Wave Shell	3	3	
Petunia Explorer Coral	2	2	
Petunia Explorer Magenta	2	1	
Petunia Explorer Pink	3	2	
Petunia Kahuna Violet	3	4	
Petunia Kahuna Whiite	2	2	
Petunia Magenta	2	3	
Petunia Misty Lilac	1	1	
Petunia Purple Wave	2	1	
Petunia Rose Pink	2	1	
Petunia Spreading Explorer Blue	3	3	
Petunia Supertunia White	2	1	
Petunia Supertunia Giant Pink	1	1	
Petunia Wave Pink	3	3	

Table 3 (continued). Maintenance Requirements of Annuals Grown in the Krohn Conservatory Trials, 2003.			
Date: 8/13/03	**Site: Hinkle Garden**		
Plant	**Dead-heading**	**Pinching/ Cutback**	**Comments**
Purple Knights Joseph's Coat	1	3	
Salvia Salvador Red	4	3	
Summer Snapdragon Angelmist Lavendar	1	2	
Verbena Silver Magic	1	3	
Verbena Superbena Blue Purple	1	1	
Verbena Superbena Burgundy	1	2	
Verbena Superbena Pink Shades	1	1	
Verbena Tukana White	1	3	
Vinca Radiant Rose Mix	1	1	

Score	Plant Maintenance Needed
1	Low
2	Low to Medium
3	Medium
4	Medium to High
5	High

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IR-4 Ornamental Trials Conducted by USDA-ARS in Ohio: 2003

Betsy A. Anderson, Michael E. Reding, Michael G. Klein, and Charles R. Krause

Summary

The Interregional Research Project No. 4 (IR-4) is a program that addresses the shortage of pest-control products registered for minor-use crops. Growers of ornamental crops should be aware of how they can benefit from this program.

IR-4 is a federally sponsored program developed to facilitate registration of new products and expand labels for effective products for minor crops. IR-4 receives funding from the U.S. Congress through the United States Department of Agriculture (USDA) which is administered by the Cooperative State Research, Education, and Extension Service (CSREES) and the Agricultural Research Service (ARS).

Individual growers, grower organizations, university researchers, and extension personnel initiate project requests. Each year a list of more than 4,000 researchable ornamental projects is compiled that includes trials of insecticides, fungicides, nematicides, bactericides, and herbicides.

Betsy A. Anderson, IR-4 Ornamentals Coordinator; Michael E. Reding, Research Entomologist; Michael G. Klein, Research Entomologist; and Dr. Charles R. Krause, Research Leader, Plant Pathologist, U.S. Department of Agriculture, Agricultural Research Service, Application Technology Research Unit, Wooster, Ohio.

Data collected from selected trials is sent to IR-4 Headquarters for review and coordination with the company making the product, and submission is made to the EPA for registration approval.

Introduction

Each year the USDA/ARS Application Technology Research Unit (ATRU) in Wooster, Ohio, receives funding from USDA/ARS to conduct IR-4 testing on The Ohio State University's Ohio Agricultural Research and Development Center (OARDC) campus in Wooster and in Ohio nurseries. Selected greenhouse, field- and container-grown ornamental plant projects are conducted in Wooster.

OARDC provides field and greenhouse space and a hoop house in Secrest Arboretum where most of the field-container testing takes place. Most of the data needed for product registration is for phytotoxicity, but the IR-4 program has determined that efficacy data is also a main concern.

For the past three years, ATRU has prioritized testing of new insecticide chemistries and collection of efficacy data on the European chafer and oriental beetle. These non-native insect species are emerging nursery pests in field-grown and container stock.

Methods and Materials

Each test included untreated control plants and three pesticide treatment rates — 1X (the rate recommended by the manufacturer), 2X, and 4X. The tests had either four or six replications.

Field container test plants were transplanted into two-gallon containers using an amended pine-bark medium and set up in an outdoor nursery in a randomized complete block design. Field test herbaceous perennials, trees, and shrubs were planted in rows separated by rows of grass in a completely randomized design. Greenhouse plants were planted in one-gallon containers and placed on benches in a greenhouse. Plants were rated for phytotoxicity four times during the growing season, after the first treatment.

Efficacy data was requested for insecticide trials using thiamethoxam (Flagship) relative to potential regulation for control of oriental beetle larvae *(Anomala orientalis)*. For this efficacy test, container test plants *(Spiraea* sp. 'Little Princess') were caged and infested with adult oriental beetles. Each plant cage received three pairs of adult beetles. The plants remained caged until no signs of living adults were found on the plants (30 days). Sixty days after the initial infestation of adults, the plant root balls were examined for grubs.

Results

Most trials showed no phytotoxicity, although the herbicide Dithiopyr (Dimension Ultra WSP) caused severe stunting on two plant species, *Impatiens* sp. and *Veronica* sp. along with necrosis on *Veronica.*

Phytotoxicity results are listed in Table1.

Efficacy data were obtained for the fungicide test using *Bacillus licheniformis* SB 3086 for control of Phytophthora root rot on *Aster* x *Frikartii* in the greenhouse. The control plants became yellow with brown discoloration at the base of stems.

A plant was submitted to Ohio State University's C. Wayne Ellett Plant and Pest Diagnostic Clinic to determine the presence or absence of *Phytophthora* spp. disease organisms. The plant tested positive for Phytophthora stem and root rot. During the course of the test, all control plants died from these symptoms while all treated plants remained healthy.

Data was also obtained from a container test using the insecticide thiamethoxam (Flagship) for control of oriental beetle (OB) larvae *(Anomala orientalis).* Containerized spiraea plants were caged and infested with three pairs of adult oriental beetles. Sufficient time was needed for females to lay eggs in the potting soil, for the eggs to hatch, and the larvae to feed and mature to second or third instar grubs.

Sixty days after the initial infestation of adults, the plants were individually dumped, and the soil and root balls searched for grubs. The untreated plants were heavily infested (mean 22.5); the plants treated with the recommended rate had a significant reduction of grubs (86.7%); and the plants with the 2X and 4X rates had no surviving grubs.

Efficacy results are listed in Table 2.

Note

Drs. Klein and Krause of Wooster, Ohio, and Dr. James C. Locke, USDA, ARS, ATRU, Research Plant Pathologist, Toledo, Ohio, serve as Liaison Representatives for the USDA, ARS, IR-4 Program and all of

Table 1. Phytotoxicity Results From 50 Tests Conducted by USDA-ARS in Wooster, Ohio During 2003.			
Pesticide	**Crop**	**Site**	**Phytotoxicity**
INSECTICIDES			
Thiamethoxam (Flagship25WG) To control white grubs, Japanese beetle larvae, and European chafer larvae.	Althea	Field	0
	Black-Eyed Susan	Field	0
	Black-Eyed Susan	Field Container	0
	Butterfly bush	Field Container	0
	Dogwood, flowering	Field Container	0
	Lilac	Field	0
	Lilac	Field Container	0
	Dianthus	Field Container	0
	Spiraea	Field	0
	Spiraea	Field Container	0
	Stonecrop	Field Container	0
	Tickseed	Field Container	0
Buprofezin (Applaud 70WP) To control leaf hoppers, scales, pod gall.	Viburnum, Arrowwood	Field Container	0
	Crabapple	Field Container	0
	Honeylocust	Field Container	0
	Maple	Field	0
	Oak	Field Container	0
FUNGICIDES			
Acibenzolar (Actigard50WP) For *Pseudomonas* and *Xanthomonas* pathogens.	Crabapple	Field	0
	Maple, Norway	Field	0
	Lilac	Field	0
	Spruce, Colorado	Field	0
Bacillus licheniformis SB 3086 (Novo-guard) For root rots	Ageratum	Greenhouse	0
	Ageratum	Field Container	0
	Aster 'Frakarti'	Greenhouse	0
	Aster 'Frakarti'	Field Container	0
	Impatiens	Greenhouse	0
	Impatiens	Field Container	0
	Beard-tongue	Greenhouse	0
	Beard-tongue	Field Container	0
	Columbine	Greenhouse	0
	Columbine	Field Container	0
	Dahlia	Greenhouse	0
	Dahlia	Field Container	0
	English ivy	Field Container	0
	Juniper	Field Container	0

Table 1. Phytotoxicity Results From 50 Tests Conducted by USDA-ARS in Wooster, Ohio During 2003.

Pesticide	Crop	Site	Phytotoxicity
FUNGICIDES (continued)			
	Pansy	Field Container	0
	Verbena	Greenhouse	0
	Zinnia	Greenhouse	0
HERBICIDES			
Isoxaben (Gallery 75 DF) For weeds, broadleaf & annual grasses and liverwort.	Bayberry	Field Container	0
	Crabapple	Field Container	0
	Holly, American	Field Container	0
	Dogwood, Kousa	Field Container	0
	Maple, Red	Field Container	0
Halosulfuron (Manage 75 WDG) For Nutsedge	Boxwood	Field Container	0
	Crabapple	Field Container	0
	Hemlock	Field Container	0
	Dawn Redwood	Field	0
Dithiopyr (Dimension ultra WSP) For weeds, broadleaf & annual grasses and liverwort.	Veronica	Field Container	*1x, 2x, 4x
	Purple coneflower	Field Container	0
	Impatiens	Field Container	*1x, 2x, 4x

* Phytotoxicity was noted on some or all of the plants with these treatment rates.
0 = None of the test plants showed phytotoxicity.

Table 2. Results of Thiamethoxam Trial Against Oriental Beetle Larvae (*Anomala Orientalis*) in Containerized Spiraea 'Little Princess' Plants.

Treatment	Rate / 100 Gal.	Mean OB Larvae Per Pot
Untreated control		22.5a
Flagship 25 WG (1x)	4 oz	3.0b
Flagship 25 WG (2x)	8 oz	0.0b
Flagship 25 WG (4x)	16 oz	0.0b

Means in columns followed by the same letter are not significantly different (Tukey's HSD multiple range test, alpha = 0.05).

the authors participate in the National IR-4 Ornamentals Workshops.

Nursery growers should let their pest-control needs be known by submitting a request electronically from the IR-4 web site at:

http://ir4.rutgers.edu/

or by calling or e-mailing Betsy Anderson, USDA/ARS, 330-263-3898 or anderson.523@osu.edu.

Acknowledgments

Special thanks to Secrest Arboretum for the use of facilities and donations of plant material for IR-4 work.

Disclaimer

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Apple Scab on Crabapple At Secrest Arboretum: 2003

James A. Chatfield, Erik A. Draper, and Kenneth D. Cochran

"Crabapple cultivars generate tens of millions of dollars in wholesale revenues for Ohio nurseries each year. This was not always the case, as important diseases resulted in reduced demand. Market demand for crabapples was revitalized by research at OARDC (the Ohio Agricultural Research and Development Center) that identified disease-resistant varieties. The research created a higher-value product for the consumer while decreasing production expenses for the grower."

— Letter from the Ohio Nursery Landscape Association to the Ohio General Assembly, 2003

Summary

Crabapple evaluation research at The Ohio State University's Ohio Agricultural Research and Development Center's Secrest Arboretum has a long history, commencing decades before the establishment there of an International Ornamental Crabapple Society National Crabapple Evaluation Program plot in 1983.

These evaluations, both for horticultural features and for disease-resistance ratings, continue to the present in the Crablandia II plot at Secrest, where 68 taxa of a planned 80 are now in a randomized replicated plot. In addition, hundreds of trees planted along the roadways of the arboretum are the biggest annual horticultural draw to the arboretum during the spring flowering period. Additional plots are in the planning stage at OARDC and Secrest for evaluation of edible crabapples.

Ohio State University's leadership in crabapple research continues with Ohio State faculty serving in leadership positions within the International Ornamental Crabapple Society (board

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president and board member) and with the appointment in 2003 by the International Society of Horticultural Science of an Ohio State faculty member and the Secrest Arboretum as the International Cultivar Registration Authority for ornamental *Malus*.

Introduction

Apple scab disease caused by the fungal pathogen *Venturia inaequalis* continues to be the key disease that limits the ornamental appeal of crabapples for landscape and commercial use. Evaluation of crabapple taxa for apple scab therefore continues for both newer and older crabapple taxa as a primary activity of the International Ornamental Crabapple Society.

Because of wet spring weather, pressure from apple scab was high at Secrest Arboretum of the Ohio State University's Ohio Agricultural Research and Development Center (OARDC) in 2003. Yet, even under this considerable disease pressure, 19 of the 68 taxa in the Crablandia II Evaluation Plot showed no evidence of apple scab in 2003. This points out that genetic disease resistance is a key practical disease control approach for apple scab on crabapple.

Materials and Methods

Sixty-eight crabapple taxa were planted in 1997–1999 at OARDC's Secrest Arboretum in Wooster, Ohio, in a completely randomized design. There are five replicate plants for each taxa with the exception of 'Beverly,' 'Scarlet Brandywine,' 'Canterbury,' 'Callaway,' 'Cardinal,' 'Indian Magic,' 'Jewelberry,' 'Red Jade,' and 'Royal Scepter,' for which there are four replicates, and 'Brandywine,' 'Hamlet,' 'King Arthur,' 'Silver Moon,' and 'American Spirit' for which there are three.

Plants were mulched with composted yard waste and irrigated as needed during the year of transplanting. Weeds were controlled with spot applications of glyphosate.

On June 2, July 2, and August 14, 2003, all trees were rated on a scale of 0 to 5, with:

0 = No scab observed.

1 = Less than 5% of leaves affected and no aesthetic impact.

2 = 5% to 20% of leaves affected, with some yellowing but little or no defoliation, moderate aesthetic impact.

3 = 20% to 50% of leaves affected, significant defoliation and/or leaf yellowing, substantial aesthetic impact.

4 = 50% to 80% of leaves affected, severe foliar discoloration and defoliation, severe aesthetic impact.

5 = 80% to 100% of foliage affected, with 90% to 100% defoliation.

Results and Discussion

Apple scab ratings of crabapples at Secrest Arboretum for the 2003 season are presented in Table 1. Here are key findings.

1. This was a high scab year for the plot. For example, 30 of the 68 taxa rated exhibited "significant defoliation and/or leaf yellowing, and substantial aesthetic impact" (a rating of 3) or worse) by the August 14 rating period. This compares to 19 in 2002 and 20 in 2001.

2. Despite this level of scab pressure, 19 of the taxa exhibited no scab in 2003, and an additional 19 taxa exhibited

Table 1. Apple Scab at Secrest Arboretum in Wooster, Ohio, in 2003.			
Crabapple Taxon	**Aug 14**	**Jul 2**	**Jun 2**
'Adirondack'	0.00	0.00	0.00
'Bob White'	0.00	0.00	0.00
'Canterbury'	0.00	0.00	0.00
'Cardinal'	0.00	0.00	0.00
'Firebird'	0.00	0.00	0.00
'Foxfire'	0.00	0.00	0.00
'Golden Raindrops'	0.00	0.00	0.00
'Holiday Gold'	0.00	0.00	0.00
'Jackii'	0.00	0.00	0.00
'King Arthur'	0.00	0.00	0.00
'Lollipop'	0.00	0.00	0.00
'Louisa'	0.00	0.00	0.00
'Prairie Maid'	0.00	0.00	0.00
'Rawhide'	0.00	0.00	0.00
'Silver Moon'	0.00	0.00	0.00
'Strawberry Parfait'	0.00	0.00	0.00
'Tina'	0.00	0.00	0.00
M. sargentii	0.00	0.00	0.00
'Royal Raindrops'	0.00	0.00	0.00
'Sinai Fire'	0.20	1.00	1.00
'Hamlet'	0.33	0.00	0.00
'Camelot'	0.40	0.40	0.20
'Callaway'	0.50	0.00	0.00
'Dolgo'	0.60	0.60	0.60
'Excalibur'	0.60	0.60	0.00
'Prairifire'	1.00	0.80	0.40
'Red Jewel'	1.00	1.00	0.60
'Beverly'	1.20	0.25	0.00
'Guinevere'	1.20	0.80	0.80
'Candymint'	1.40	1.00	1.00
'Pink Princess'	1.80	1.00	0.20
'Cinderella'	2.00	2.00	1.20
'Lancelot'	2.00	1.00	0.60
'Mary Potter'	2.00	2.00	1.80
'Purple Prince'	2.00	1.40	1.00
'Scarlet Brandywine'	2.25	1.50	1.25
'David'	2.80	2.00	2.00
'American Salute'	3.00	3.00	2.00

Table 1 (continued).Apple Scab at Secrest Arboretum in Wooster, Ohio, in 2003.			
Crabapple Taxon	**Aug 14**	**Jul 2**	**Jun 2**
'Manbeck Weeper'	3.00	2.80	1.80
'Molten Lava'	3.00	2.00	1.00
'Royal Fountain'	3.00	2.80	1.80
'Red Jade'	3.00	2.00	2.00
'Canary'	3.20	2.80	2.00
'Coralburst'	3.20	3.00	1.00
'Professor Sprenger'	3.20	300	2.00
'Brandywine'	3.25	2.00	1.75
'Adams'	3.40	2.80	2.20
'Sugar Tyme'	3.40	3.00	2.00
'Sentinel'	3.40	2.60	1.80
'Thunderchild'	3.40	3.00	2.00
'Red Splendor'	3.60	2.60	2.00
'Silver Drift'	3.80	2.80	1.80
'Doubloons'	4.00	2.20	1.60
'Donald Wyman'	4.20	2.80	2.00
M. floribunda	4.00	2.60	2.00
'Harvest Gold'	4.00	3.00	2.00
'Indian Magic'	4.60	3.00	2.00
'Pink Satin'	4.60	3.60	2.00
'Spring Snow'	4.60	3.00	2.00
'Snowdrift'	4.20	3.00	2.00
'Weeping Candied Apple'	4.20	3.80	2.00
'Jewel Berry'	4.60	3.30	2.00
'White Cascade'	4.60	3.00	2.20
'Royal Scepter'	4.80	2.20	2.00
'American Masterpiece'	5.00	3.00	2.00
'American Spirit'	5.00	3.00	2.00
'American Triumph'	5.00	3.00	2.00

* 0 = no scab observed;
1 = less than 5% of leaves affected and no aesthetic impact;
2 = 5% to 20% of leaves affected, with some yellowing but little or no defoliation, moderate aesthetic impact;
3 = 20% to 50% of leaves affected, significant defoliation and/or leaf yellowing, substantial aesthetic impact;
4 = 50% to 80% of leaves affected, severe foliar discoloration and defoliation, severe aesthetic impact; and
5 = 80% to 100% of foliage affected, with 90% to 100% defoliation.

scab with less than substantial aesthetic impact as of the August 14 rating period. This wide range of crabapples with good scab resistance, crabapples that also have diverse horticultural features, from uprights to weepers, from pink-flowered to white-flowered types, from red- to purple- to yellow-fruited, suggests that landscape managers have the option of selecting a wide palette of crabapples for the landscape.

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How Do the Oregon and Ohio Hispanic Nursery Workforces Differ?

Hanna M. Mathers

The greenhouse and nursery industry is the second most important agricultural sector in the United States in terms of economic output (7). The wholesale nursery industry was the largest sector in horticultural sales in the United States in 1998, representing 29.2% of a $10.6 billion industry.

Oregon and Ohio are two major nursery production states, ranking third and fourth nationally, respectively (15). In 1996, the nursery/landscape industry contributed an estimated $659.7 million to Ohio's economy through employee payroll (14). Ohio nursery stock dealers and producers provided statewide employment opportunities for an estimated 31,651 year-round full-time workers, 17,437 year-round part-time workers, and 41,548 seasonal workers (14).

In 1997, the nursery wholesale industry contributed an estimated $179 million to Oregon's economy through employee payroll (10). Nursery stock producers provided statewide employment opportunities for 8,050 year-round full-time workers and 12,750 seasonal workers (10).

Approximately 60% of the Ohio nursery industry workforce and 90% of the Oregon workforce is composed of Hispanic employees who fill year-round full-time, year-round part-time, and seasonal positions (12).

Many of these Hispanic employees in both states understand little English. Spanish is their primary language. Little information is available in Spanish to Hispanic nursery, landscape, and retail workers and managers (4).

Several complicated issues exist in securing a stable nursery industry workforce for today's U.S. nursery industry. These issues include legalization, availability and retention of workers (9), and reduction of workforce as a result of mechanization (5). Labor shortages and maintaining a stable work force were the Ohio Nursery and Landscape Association's (ONLA) highest-rated needs affecting the industry (13).

J. Frank Schmidt & Son Co., Boring, Oregon, one of Oregon's larger nursery stock producers, indicated that labor is the nursery industry's No. 1 issue nationally (9).

One way to address these labor issues is by surveying the Hispanic workers in Oregon and Ohio. The goal of these surveys was to better understand the backgrounds and technical needs of this audience in order to help stabilize and engage the existing work force through

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education. Our expectation was that Hispanic employees could advance and work more effectively and productively through education and training.

Another issue involved in securing a stable nursery industry workforce is the seasonal nature of the industry, with peak activity time occurring in the spring (8). The Ohio nursery industry is more seasonal than the Oregon industry; however, both states face the same immense challenge of hiring enough seasonal workers to fill spring demands.

Many workers from foreign countries want to fill seasonal and full-time nursery positions that are unwanted by sufficient numbers of U.S. workers. The main reason Mexican workers want U.S. jobs is the superior pay of positions in the United States.

Labor in Mexico is abundant and cheap (3). The average salary for an autoworker at a Mexican assembly plant is $0.90/hour (3), compared to U.S. nursery workers, who may make approximately $9.00 to $12.00/hour.

The Immigration and Naturalization Service (INS) Immigration Reform and Control Act (IRCA) of 1986 created two visa programs to help nursery (H2A program) and landscape (H2B program) employers find seasonal alien laborers (6). The majority of certified workers from these programs come from Mexico (3). Despite the provision of these programs, a small number of alien workers enter the payrolls of U.S. firms through sanctioned programs.

Particularly small nursery companies often overlook the H2A program as an option because of the complexity and overlap in regulations from the Department of Labor (DOL), Immigration and Naturalization Service (INS), and Department of State (8). The INS reports as many as 50,000 migrants are crossing the U.S.-Mexico border illegally each month (3) and that 40% of seasonal agricultural workers are illegal (2).

Although the majority of positions held in the nursery industry are seasonal in nature, nursery employers would like employees to return year after year to reduce training needs and build on their experience base (9). Traditionally, the crew leader, production manager, and other supervisory positions are filled from the ranks of seasonal workers who return for multiple years. Attracting a seasonal labor pool to return year after year is a difficult challenge; however, job satisfaction seems to figure high in this scenario (11, 16).

Currently, there are few reference materials for Spanish-speaking employees. Because of this, Spanish-speaking workers cannot stay informed of changes in the laws, recent innovations, new practices, or pesticides. The delivery of technical information to Hispanic employees in Oregon and Ohio by means of a Spanish Newsletter, web site, and educational programs has been one of the first efforts to fulfill this need in the United States (12).

The owners of Ohio and Oregon nurseries and landscape and garden retail businesses view education of employees as essential to job satisfaction (personal communication). They realize that the managers and supervisors of the next five to 10 years will come from the ranks of the Hispanic workforce. Therefore, technical services must be provided to these workers.

These industries realize that education sparks interest, and interested employees are likely to remain in the industry workforce and work more efficiently. If workers minds are challenged and their knowledge base is increased, the nursery

industry gains better, more successful, and satisfied employees.

In Oregon and Ohio, 375 and 250 surveys, respectively, were distributed to Spanish-speaking nursery employees. In Oregon 193 and in Ohio 127 surveys were completed. The purpose of these surveys was to determine the backgrounds, experience level, and work activities of nursery workers; their technical information interests; and what resources are available to these workers.

The survey response came from three sources — interviews at training programs, on-farm visits, and mailed surveys in a newsletter format. The survey targeted crew leaders, forepersons, and section supervisors, such as propagation area supervisors. These positions are generally supervised by an English-speaking or bilingual nursery production manager.

We reached only those Hispanic employees in both states that the nursery owners felt "merited" the exposure to training programs, newsletters, or on-farm visits. The surveys in Oregon occurred between May 1998 and August 2000. The surveys in Ohio occurred between September 2000 and July 2002. The same multiple-choice and fill-in-the-blank questions were asked in all three formats, in both states.

Background, Experience Level, and Topics of Interest

Several differences, besides the relative percentages of Hispanics filling the workforce, were found between Oregon and Ohio from the survey responses. In Oregon, the employees were primarily Mexican in background. In Ohio, the backgrounds were more diverse and included people from Guatemala, Puerto Rico, Brazil, Nicaragua, and Mexico. This indicates that there are more cultural and language dialect differences that need to be considered for the Ohio audience. Keeping people from the same country within a crew will mean that a better worker rapport is developed (16). With the diversity that exists in the Ohio workforce, this rapport building may be more of a challenge.

In Oregon, the average survey respondent had 10 years of U.S. nursery experience. Often, the Hispanic crew leader level of staff had 20 to 25 years of experience. Additionally, they had worked all these years at the same nursery. Many of these Oregon crew leaders had high school and occasionally college degrees from Mexico. Many had a considerable grasp of English and were fluent in Spanish.

We found that Ohio's Latino workers had less experience in the nursery industry than the workers in Oregon and the experience level varied across the state. In central and southern Ohio, survey respondents had an average of two years of nursery experience. In northeastern Ohio, the average survey respondents had worked seven years in U.S. nurseries. Some Hispanic crew leaders in northeastern Ohio had 15 years of experience.

The Hispanic workers surveyed in Oregon indicated 60% of their information came from their bilingual supervisors. The other three educational resources currently available to these workers, in order of importance, were books, other Hispanic coworkers with more experience, and outside professionals, such as Extension personnel.

In Ohio, 90% of workers indicated their bilingual supervisor was their primary learning resource. Less than 10% in Ohio indicated that they had access to books

or outside professionals through their employers. Also, in Ohio, due to the lack of experience base, less mentoring of newer workers was occurring.

The technical topics of greatest interest for surveyed Ohio employees were plant identification (95%) and weed control (90%). This was quite different from the survey results in Oregon. In Oregon, eighty-one percent replied that insect control information was their leading technical information interest, with 77% indicating weed control and 66% disease control. Other interests were nutrition at 55%, propagation 47%, and plant identification 45%.

The differences in experience levels between the two states means a greater challenge exists in Ohio in the conveying of technical information, particularly in central and southwestern Ohio. For example, there could be a nutrition problem that causes a plant to appear yellow, but the normal color of the plant may be yellow.

The central and southwestern Ohio workers may not know the name or normal color of the plant. There's a big need for very basic technical information, particularly for this Ohio audience.

Ohio workers in central and southwestern Ohio also indicated in conversations during the on-farm surveys that without basic plant identification skills, they could not engage in jobs such as shipping, quality control, and/or inventory, which they felt were jobs in which they could advance.

Hispanic employees in Oregon and Ohio were found to be involved in virtually every aspect of nursery production; however, Hispanic workers were very active in performance of pest management activities and several propagation activities in both states. Less than 5% of those surveyed in either state were women. Few Hispanic women have risen to crew leader or section supervisor. Those Hispanic women surveyed were advancing predominantly in plant propagation in both states.

One criticism that we have received about these projects was that it appears we are advocating that Hispanic workers not learn English. This, however, was not the objective or the result of this work. We have observed in both states, the fastest-advancing workers are often bilingual, and those companies that are experiencing the least turnover in their workforce and the highest worker productivity are companies that are establishing English lesson sessions for their Hispanic employees (16).

Learning English is key to success in any industry in the United States; however, it is hard enough to learn technical material, let alone learn it in another language. Providing *ayuda técnica* — technical help — in their native languages is just one way to speed the development of these workers in their efforts to advance in the industry. Also, the presentation of material in Spanish has been viewed by many Hispanic workers in both states as an acknowledgement and even an extension of appreciation of their culture and the contribution these workers are filling in the U.S. nursery industry.

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Franklin County Extension Pesticide Survey, 2002

Marilyn Golightly, Dorothy Pettenski, and Jane C. Martin

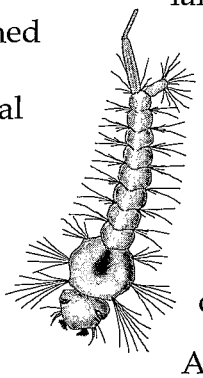
Summary

A team of Franklin County Master Gardener volunteers (MGs), directed by Extension Agent Jane Martin, conducted monthly surveys (March through August of 2002) at 10 retail outlets in Franklin County, looking for specific pesticides available for homeowner use. Three outlets were independent family-owned garden centers; two were Ohio-based chain stores; and the rest were national multi-purpose chain stores.

Each month, a fungicide, an herbicide, and an insecticide were surveyed. Forty-three active ingredients or combinations of products were surveyed, and 141 brand names were found, which represented different manufacturers, formulations, or product combinations.

In the period from March through August, each of the three independent family-owned garden centers had more brands of pesticides for homeowner use and products with a greater variety of active ingredients than each of the other seven retail outlets. In this survey, retail outlets carried similar pesticide merchandise in comparable corporate branches, regardless of whether Ohio-based stores or different national multi-purpose chains were evaluated.

The biological pesticides found were corn gluten (a pre-emergent herbicide), *Bacillus thuringiensis* var. 'Israelensis' (for mosquito larvae), and *Bacillus thuringiensis* var. kurstaki (for caterpillars). All outlets carried lawn fertilizers which contained an insecticide (Step 3), a long residual control product for grubs, and a dormant or horticultural oil, but disulfoton (Di-syston®) was slightly more difficult to find.



All stores carried triforine (Funginex®), a fungicide for ornamental plants, but other fungicides were less available, including captan, copper, propiconazole, and those for treating lawns. Herbicides appeared to be widely available in the seasons for successful control of weeds.

A variety of controls for deer, moles, and slugs were widely available.

Introduction

The *Buckeye Yard and Garden Line (BYGL)* is one of the key ways through which Ohio State University Extension and the Extension Nursery, Landscape, and Turf Team (ENLTT) provide information to the

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green industry, Extension offices, and the general public.

A pesticide survey was proposed by ENLTT for 2002 to gather information for *BYGL* on specific products available for homeowner use throughout the growing season. Garden centers of different types in different geographic locations in Franklin County were chosen to provide the Franklin County Extension office consumer garden information line with local market place information.

This report includes a compilation of pesticide information collected in monthly surveys conducted by nine Master Gardeners (MG) in 10 retail outlets during March through August 2002.

Methods and Materials

Ten retail outlets of three different types and representing different geographic locations in Franklin County were selected for this survey (Table 1).

Garden centers 1, 2, and 3 are local family-owned and operated stores. Each has a large production facility and has multiple locations in the Columbus area. They included Oakland Nursery at 1156 Oakland Park, Plantland at 2900 Bethel Road, and Strader's at 5350 Riverside Drive.

Both garden centers 4 and 5 are associated with Ohio general stores that have branches throughout the state. In this report, these two popular garden centers represent a transition between a family-owned garden store and those in national chain stores. These included Anderson's East at Brice Road and Anderson's North at 700 Bent Tree Blvd.

The remaining five garden centers are connected to large multi-purpose, national chain stores and included Home Depot at 6333 Cleveland Avenue, Lowe's Central at 2345 Silver Drive, and Lowe's East at 2888 Brice Road, Sears Hardware at 90 Graceland Boulevard, and Wal-Mart at 5900 Britton Parkway.

The method used for gathering pesticide information for *BYGL* and Franklin County Extension involved a five-step process:

1. Three types of pesticides were selected every month, from March to August by the ENLTT. Pesticides were usually surveyed at the appropriate time for availability and application. The names of the active ingredients on the monthly survey were sent to co-leaders of the MG survey team.

2. One of the co-leaders went to six garden centers in the northern half of Franklin County to find brand-name products that contained the active ingredients. The six sites used for this purpose were garden centers 1, 2, 3, 5, a corporate branch of 6, and a corporate branch of 7 and 8 that previously were chosen for the official survey of pesticides (Table 1). These were Oakland Nursery at 1156 Oakland Park, Plantland at 2900 Bethel Road, Strader's at 5350 Riverside Drive, Andersons at 700 Bent Tree Boulevard, Home Depot at 5858 Sawmill Road, and Lowe's at 3600 Park Mill Run Drive.

3. Information collected at these six garden centers was organized into a preliminary table that listed active ingredients, product names, and product formulations. Both trade names and chemical nomenclature were provided when a need was anticipated as an aid for MGs to

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Table 1. 2002 Pesticide Survey, Franklin County.												
	Oak-land	Plant-land	Stra-ders	Ander E	Ander N	Home Depot	Lowes E	Lowes Cen	Sears Hrdw	Wal-mart	%*	Comment
Type of Store	family	family	family	Ohio	Ohio	nat'l	nat'l	nat'l	nat'l	nat'l		
Garden Center Code	1	2	3	4	5	6	7	8	9	10		
County Location	Centrl	NW	W	SE	NW	NE	SE	Centrl	N	W		
Month/Pesticide Surveyed												
MARCH												
Pendimethalin	x	x	x	x	x	x	x	x	x	x	100	
Thiophanate-methyl	x	x	x	x	x		x	x			70	
Dormant oils	x	x	x	x	x	x	x	x	x	x	100	
Horticultural oils	x	x	x	x	x	x	x	x	x		90	
Corn gluten	x	x	x								30	
APRIL												
Trifluralin	x	x	x	x	x	x	x	x	x	x	100	
Captan	x	x	x	x	x				x		60	
Imidacloprid (Merit)	x	x	x			x	x	x	x	x	80	
Halofenozide (Mach2)	x	x	x	x	x	x		x	x	x	90	
Dursban			x?								10?	false positive?
MAY												
Triforine (Funginex)	x	x	x	x	x	x	x	x	x	x	100	
Triclopyr	x	x	x			x	x	x	x	x	80	
Disulfoton (Di-Syston)	x	x	x	x	x					x	60	
Lindane											0	
Triadimefon (Bayleton)									x		10	
JUNE												
Metaldehyde	x	x	x			x	x	x			60	
Metaldehyde + Carbaryl (Sevin)	x	x	x		x		x				50	
Iron phosphate	x	x									20	
Aluminum sulfate			x								10	
Diatomaceous earth						x					10	
Bt var. kurstaki	x		x								20	
Bt var. 'Israelensis'	x	x									20	

Table 1 (continued). 2002 Pesticide Survey, Franklin County.												
	Oak-land	Plant-land	Stra-ders	Ander E	Ander N	Home Depot	Lowes E	Lowes Cen	Sears Hrdw	Wal-mart	%*	Comment
Type of Store	family	family	family	Ohio	Ohio	nat'l	nat'l	nat'l	nat'l	nat'l		
Garden Center Code	1	2	3	4	5	6	7	8	9	10		
County Location	Centrl	NW	W	SE	NW	NE	SE	Centrl	N	W		
Month/Pesticide Surveyed												
JUNE (contd)												
Bt var. 'San Diego'											0	
4-Step Lawn Care Programs												
Step 1												
Pendimethalin (Lesco)						x					10	
Pendimethalin (Scotts)	x	x			x	x	x	x			60	
(Benefin), trifluralin	x				x						20	store brand
Dithiopyr		x				x					20	
Prodiamine		x									10	store brand
Step 2												
2,4-D, MCPP						x	x	x		x	40	
2, 4-D, MCPP, dicamba		x		x	x	x	x	x	x		70	
2,4-D, MCPP, dichlorprop	x			x	x	x				x	50	
Step 3												
Bifenthrin	x	x	x	x	x	x	x		x	x	90	
Diazinon				x	x	x		x			40	store brand
Step 4												
Fertilizer only	x	x	x	x	x	x	x	x			80	store brand
JULY												
Mole control products:												
Castor oil	x	x		x	x						40	
Castor oil and soybean oil						x	x	x			30	
Zinc phosphide	x	x	x	x	x		x	x			70	
Sulfur, potassium nitrate, char	x		x	x	x						40	
Mechanical trap	x			x	x	x	x	x			60	
Propiconazole (Banner)	x	x	x								30	

Table 1 (continued). 2002 Pesticide Survey, Franklin County.												
		Plant-land	Stra-ders	Ander E	Ander N	Home Depot	Lowes E	Lowes Cen	Sears Hrdw	Wal-mart	%*	Comment
Type of Store	family	family	family	Ohio	Ohio	nat'l	nat'l	nat'l	nat'l	nat'l		
Garden Center Code	1	2	3	4	5	6	7	8	9	10		
County Location	Centrl	NW	W	SE	NW	NE	SE	Centrl	N	W		
Month/Pesticide Surveyed												
JULY (contd)												
Fixed copper or Bordeauz mix	x	x	x	x	x						50	
AUGUST												
Deer repellents	x	x	x	x	x	x		x			70	
Trimec	x	x	x	x	x		x	x			70	
* = Percent of retail outlets carrying product												

identify additional brand names of products. Trade names and the chemical nomenclature for active ingredients were obtained from the Pesticide and Metabolite Standards Catalog from Chem Service, Inc., West Chester, Pa.

4. Preliminary tables were sent to the nine MGs who were asked to record pesticide data anytime during the particular month at their assigned garden center. They were asked to add brand names of additional products that contained the active ingredients on the survey, if found.

5. Members of the survey team reported their findings to two co-leaders who prepared a summary table of results at the end of each month. The six summary tables were sent to the Extension agent, who interpreted and distributed the results to others.

Results and Discussion

On average, more surveyed pesticides and more brands were found in the family-owned and operated garden centers (1, 2, and 3) than in garden centers in Ohio general stores (4 and 5) or in garden centers associated with national chains (6, 7, 8, 9, and 10) (Table 1). Surveys indicated that both branches of the Ohio general store had remarkably similar types of pesticides, although managers at each branch could determine quantity and types of products for their store.

Garden center 6 is connected to a national home improvement center. The brand names of pesticides found in a corporate branch of this home improvement center were collected for the preliminary table sent to the nine MGs. Comparison of the data from these two branches indicated that garden center 6 had a few more brand-name products, especially in March and April, than the garden center which was used for collecting preliminary data. However, a real difference may not exist

because data from these two garden centers often were collected approximately one month apart.

Garden centers 7 and 8 are branches of a large national chain of home improvement centers. Information for the preliminary table was obtained from a corporate branch of these two home-improvement centers. Results indicated that the brand names sold in these garden centers were virtually identical for all active ingredients surveyed in all six months of the survey.

Master Gardeners could not find products on both the July and August surveys in garden centers 9 and 10. In addition, the sum of all pesticide merchandise for garden use in these two stores was reported to be low during the August survey.

Forty-three active ingredients (or combinations of active ingredients) were surveyed, and 141 separate brand-name products were found in 10 retail outlets in Franklin County from March through August 2002 (Table 2). A few brand names are followed by "not on list" to indicate these products were not listed on the preliminary table sent to MGs at the beginning of each month. These brand names were later found to contain the active ingredients of interest. Some brand names are followed by "not on list, but reported" because a MG reported finding a product that had not been listed.

Nine deer repellants were found representing six different active ingredients or combinations. Some of these products may also repel other mammals and birds, because manufacturers used a variety of ingredients known to have unpleasant flavors and offensive odors to discourage deer and rabbits. Seven garden centers carried at least one deer repellent in August.

The question was asked: "Are recently discontinued pesticides still available?" The report for chlorpyrifos (Dursban®), a pesticide discontinued in December 2001, may be a "false positive" for one center, since no brand name was given with the report and no product, including sealed ant baits that were approved for sale in 2002, was found at this location by a co-leader of the survey before or after the reported finding. Lindane was not found at any of the retail outlets. Only two fertilizer bags containing triadimefon (Bayleton®) were found at one garden center.

Six active ingredients for controlling fungal diseases were surveyed. Some products containing captan, triforine, and copper also contained insecticides and miticides. Label reading was important for fungicides because they could be packaged as wettable powders, liquid concentrates, ready-to-use liquids, or aerosols. Also, the concentration of active ingredients ranged widely from product to product, even in products packaged by the same manufacturer or for controlling diseases on similar plants.

Six of the 10 stores had thiophanate-methyl, a control for certain lawn diseases, but all stores carried triforine (Funginex®), a product used on roses and other ornamental plants susceptible to fungal diseases. The pesticide manager for a family-owned garden center remarked that he "orders only a small quantity of products for controlling fungus in lawns, because lawn fungus is not a big problem most years in central Ohio."

Only one national chain store had captan, and none had copper-containing fungicides; however, both family-owned (1, 2, and 3) and the Ohio general stores

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Table 2. Pesticides Available for Homeowner Use Surveyed in Franklin County, 2002.		
Active Ingredient	**Month Surveyed**	**Commercial Name of Products**
Deer Repellents		
Ammonium Soaps of Higher Fatty Acids	August	Hinder Deer & Rabbit Repellant
		Grant's Deer & Rabbit Repellant
Dried Animal Blood Plasma		Repellex Deer Repellent Ready to Use
Garlic, Potassium Sorbate, Sodium Lauryl Sulfate		Liquid Fence Animal Repellent
Putrescent Whole Egg Solids		Concern Deer Away
Putrescent Whole Egg Solids, Capsaicin, Related Capsaicinoids & Garlic		Bonide Shot-Gun Deer & Rabbit Repellent
		Deer-Off
Benzyldiethyl (Bitrex® or Bitterguard®)		Ferti-lome This-1-Works
		Ro-pel Animal, Rodent & Bird Repellent
Fungicides		
Thiophanate-methyl	March	Scotts Lawn Fungus Control
		Scotts Summer Insect & Disease Control & Lawn Fertilizer
Captan	April	Bonide Captan
		Bonide Complete Fruit Tree Spray
		Bonide Insecticide, Miticide, Fungicide
		Bonide Rose & Flower Spray or Dust
		Bonide Rose Rx Insect & Disease Control
		Bonide Rose Spray II Concentrate
		Bonide Rose Spray II Aerosol
		Ferti-lome Fruit Tree Spray
		High Yield Captan
		Ortho Home Orchard Spray

Table 2 (continued). Pesticides Available for Homeowner Use Surveyed in Franklin County, 2002.		
Active Ingredient	**Month Surveyed**	**Commercial Name of Products**
Triforine (Funginex®)	May	Ortho Orthenex Insect & Disease Control
		Ortho Rose Pride Funginex
		Ortho Rose Pride Insect & Disease & Mite Control
		Ortho Rose Pride Orthenex Insect & Disease Control
Triadimefon (Bayleton®)	May	Bayer Advanced Lawn Fungus Control
Propiconazole (Banner)	July	Ferti-lome Systemic Fungicide
Fixed Copper (or Bordeaux)	July	Bonide Copper Spray or Dust
		Bonide Liquid Copper
		Bonide Rotenone + Copper Dust
		Dragon Copper
Herbicides		
Pendimethalin	March	Scotts Crabgrass Preventer + Fertilizer (Step 1)
		Scotts Halts
		Scotts Turfbuilder + Halts
		Scotts Super Turfbuilder + Halts
Corn Gluten	March	Concern All Natural
Trifluralin	April	Andersons Crabgrass Preventer + Lawn Food
		Greenview Preen Prevents Weeds
		Greenview Preen 'n Green & Fertilizer
		Miracle-Gro Garden Weed Prevent
		Miracle-Gro Garden Weed Prevent & Plant Food
Triclopyr	May	Bonide Stump Out
		Ferti-lome Brush Killer, Stump Killer
		Greenlight Vine & Stump

Table 2 (continued). Pesticides Available for Homeowner Use Surveyed in Franklin County, 2002.

Active Ingredient	Month Surveyed	Commercial Name of Products
		Ortho Brush-B-Gone Poison Ivy, Poison Oak & Brush Killer (Conc.)
		Ortho Brush-B-Gone Poison Ivy, Poison Oak & Brush Killer (RTU)
		Ortho Weed-B-Gone Chickweed, Clover, & Oxalis Killer
Trimec	August	Bonide Lawn Weed Killer
		Ferti-lome Weed Out
		Ferti-lome Weed Out Lawn Weed Killer (Conc.)
		Ferti-lome Weed Out plus Lawn Fertilizer
		Plantland Weed & Feed
		Spectracide Brush Killer Spray (Conc.)
Insecticides		
Dormant Oil	March	Ortho Volck Spray
Horticultural Oil	March	Bonide All Season Oil
		Ferti-lome Dormant & Summer Oil
		Scalecide
		Sunspray Ultra-fine Year Round Oil
Imidacloprid (Merit®)	April	Bayer Advanced Tree & Shrub Insect Control
		Bayer Advanced Garden 2-in-1 Plant Spikes
		Bayer Advanced Lawn Season Grub Control
		Bayer Advanced Lawn Season-Long Grub Control
		Bayer Advanced Rose & Flower Insect Killer
		Scotts Grub-ex
Halofenozide (MACH2)	April	

Table 2 (continued). Pesticides Available for Homeowner Use Surveyed in Franklin County, 2002.		
Active Ingredient	**Month Surveyed**	**Commercial Name of Products**
Disulfoton (Di-Syston®)	May	Bayer Advanced Rose & Flower Care
		Bayer Advanced Rose and Flower Care
		Bonide Systemic Granules
		Bonide Systemic Rose & Flower Care
		Ferti-lome Systemic Insecticide Granules for Roses, Shrubs, Flowers & Tomatoes
		Hi-Yield Di-Syston® Systemic Insecticide
Bt. var. 'kurstaki' (caterpillars)	June	American Thuricide
		Bonide Bacillus Thurigensis
		Bonide Thuricide
		Ortho *Bt.* Biospray
		Ortho Dipel Caterpillar Spray
Bt. var. 'Israelensis' (mosquito larvae)	June	Summit Mosquito Dunks
Bt. var. 'San Diego' (beetle larvae)	June	none found
Lawn Fertilizer + Pesticides		
Step 1 – pre-emergent herbicides	June	
Pendimethalin		Lesco Pre-M Starter Fertilizer (not on list, but reported)
		Scott's Step 1-Crabgrass Preventer + Fertilizer
		Scott's Turfbuilder + Halts (not on list)
		Scott's Super Turfbuilder + Halts (not on list)
Benfluralin (Benefin®) & Trifluralin		Andersons Crabgrass Preventer
		Fortify
		Oakland Step 1
Dithiopyr		Vigro Pre-emergent Crabgrass Control + Fertilizer

Table 2 (continued). Pesticides Available for Homeowner Use Surveyed in Franklin County, 2002.		
Active Ingredient	**Month Surveyed**	**Commercial Name of Products**
Prodiamine	June (cont'd)	Ferti-lome Lawn Food + Crabgrass & Weed Preventer
Step 2 — broadleaf weed herbicide(s)		
2,4-D, Mecoprop		Scott's Step 4 (Turf Builder + Weed Control)
2,4-D, Mecoprop, Dicamba		Ferti-lome Weed-Out + Lawn Fertilizer
		Green Sweep Weed & Feed
		Lesco Weed & Feed (liquid conc.)
		Lesco Weed & Feed (liquid conc.)
		Lesco Weed & Feed (granules)
		Plantland Weed & Feed
		Scott's Weed & Feed
		Sta-Green Weed & Feed
		Sta-Green 200 Plus Weed & Feed
		Vigro Weed and Feed
2,4-D, Mecoprop, Dichlorprop		Andersons Weed & Feed
		Fortify Weed and Feed
		Lesco Weed & Feed (granules)
		Scott's Green Sweep Weed & Feed
Step 3 — insecticide		
Bifenthrin		Scott's Step 3 (Scott's Summer Guard Insect Control)
Diazinon		Andersons Lawn Insect Control + Lawn Food
		Scott's Fertilizer with Insect Control
		Vigro Lawn Insect Control + Fertilizer
Step 4		
Fertilizer, only		Andersons Lawn Food
		Lesco Starter Fertilizer
		Lesco Turf Fertilizer

Table 2 (continued). Pesticides Available for Homeowner Use Surveyed in Franklin County, 2002.		
Active Ingredient	**Month Surveyed**	**Commercial Name of Products**
		Parker's Lawn & Garden Fertilizer
		Plantland Fall/Winter Fertilizer
		Scott's Step 4 (Turfbuilder Lawn Fertilizer)
		Sta-Green Lawn Fertilizer
		Vigro Lawn Fertilizer
		Vigro Starter Fertilizer
2,4-D, Mecoprop		Scott's Super Winterizer + Weed Control (not on list)
2,4-D, Mecoprop, Dicamba		Sta-Green Lawn Fertilizer + 3 Weed Control (not on list, but reported)
Mole Control		
Castor Oil	July	Bonide Shot-Gun Mole & Gopher Repellant
		Ferti-lome Mole Go
		Mole-Med
Castor Oil, Soybean Oil		Spectracide Mole Stop Mole Repellant
Zinc Phosphate		Bonide Moletox
		Sweeney's Poison Peanuts
		U.S. Garden Sales
Sulfur, Potassium Nitrate, Charcoal		Revenge Rodent Smoke Bomb
Mechanical Metal Trap		Nash's Choker Loop Mole Trap
		Victor Mole Trap
Sonic Device		Victor Sonic Pest Chaser Model 700
Slug Control		
Metaldehyde	June	Force II Deadline
		Hi-yield Snail & Slug Killer
		Ortho Bug-Geta Snail & Slug Killer

Table 2 (continued). Pesticides Available for Homeowner Use Surveyed in Franklin County, 2002.		
Active Ingredient	**Month Surveyed**	**Commercial Name of Products**
		Ortho Snail & Slug Killer
		Spectracide Snail & Slug Killer
Metaldehyde + Carbaryl (Sevin_)		Bonide No Escape Slug & Snail Killer
		Bonide No Escape Slug & Snail Killer
		Bonide + Snail, Slug & Sowbug Bait
		Bonide Slug Bait
		Ferti-lome Eliminate
		Ferti-lome Snail, Slug & Bug Bait
		Green Light Bug & Snail Bait
		Ortho Bug-Geta + Snail, Slug + Insect Killer
		Ortho Bug-Geta + Snail, Slug + Sowbug Bait
Iron Phosphate		Sluggo
		Schultz Garden Safe Slug & Snail Bait
Aluminum Sulfate		Farmer McGregor's Snail & Slug Slaughter
Diatomaceous Earth		(not on list, but reported)

(4 and 5) stocked both of these products. Propiconazole was found in only two products, which were packaged by one company, and these products were found only in family-owned garden centers (1, 2, and 3).

The active ingredients for controlling weeds are listed in Table 2 under the heading *Herbicides* and also under *Lawn Fertilizers + Pesticides* (4-Step products). Eleven active ingredients or combinations were surveyed. Concern All Natural, which contains corn gluten, was the only brand found of any biological pre-emergent, and it was seen only at the three family-owned garden centers (1, 2, and 3).

Triclopyr, a liquid sold in ready-to-use forms or as a concentrate, is intended for use in non-crop, industrial, and wildlife openings, as well as in lawns to treat stumps and to control broadleaf weeds or woody brush. In May, triclopyr was found at eight garden centers (1, 2, 3, 6, 7, 8, 9, and 10). Pendimethalin and trifluralin, both pre-emergent herbicides, were available as individual products and mixed with fertilizers for the lawn.

Trimec herbicides for broadleaf post-emergent weed control, were available as individual products and mixed with fertilizers for the lawn. The herbicides for lawns will be discussed further with 4-Step lawn products.

Ten active ingredients for controlling insects were surveyed, but additional insecticides, such as malathion, pyrethrin isomers, permethrin and malathion, were found in combination products with fungicides that were surveyed. Disulfoton (Di-Syston®) is a systemic, organophosphate insecticide currently licensed for working into the soil around roses and non-edible ornamental plants and in the transplant hole for tomatoes.

Although disulfoton can control a wide variety of garden pests, it should never be broadcast in vegetable gardens or on lawns. Disulfoton breaks down quickly and has little residual effect, and it was found in products in six of the 10 garden centers.

All retail garden centers carried a Step-3 lawn fertilizer with an insecticide (either bifenthrin or diazinon), a dormant or horticultural oil, and a long residual product for grub control (imidacloprid or halofenozide).

Products containing insecticidal *Bacillus thuringiensis* (*Bt.* var. 'Israelensis' and *Bt.* var. kurstaki) were found only at the family-owned garden centers (1, 2, and 3). One manager said he "did not stock *Bt.* var. 'San Diego' because potato beetles are not a serious problem for homeowners in central Ohio."

Timing was important for finding *Bt.* var. 'Israelensis,' a biological agent for killing mosquito larvae. This mosquito control was not found at the beginning of June. However, Summit Mosquito Dunks, which may be floated in standing water, were found at two family-owned garden centers in mid-June. Quantities of Mosquito Dunks fluctuated greatly through July and August in the garden center that displayed this product at eye level and also sold water garden plants and supplies.

The noted fluctuation probably was a response to news reports of the recent spread of West Nile virus, a disease spread by mosquitoes that are plentiful in central Ohio, and the ability of the garden center to replenish its supply.

The preliminary table for 4-Step lawn products was unusually long and contained both national brands and store brand products. Unfortunately, a few Step-1 and Step-4 herbicide-containing

products were not listed on the preliminary table because either they were not seen in late May in any of the six garden centers used to obtain brand name information or were seen, but inadvertently not listed, which was the situation for Scott's Super Winterizer Plus Weed Control.

Careful label reading was needed to determine the active ingredients for pre-emergent herbicides combined with lawn fertilizers (Step-1), because the bags could contain one or two of five chemicals, and this information could be in small print on either the front or the back of a heavy bag. However, reading the labels on broadleaf post-emergent herbicides (Step-2) required even greater skills, because the active ingredients could be one of three combinations of chemicals, and all were listed with the long chemical names rather than the shorter common names.

Products from one manufacturer illustrate how confusing herbicide-label reading can be for homeowners. For example, Lesco's Weed and Feed was applied to both a liquid concentrate and two granular products, all with three active ingredients. The last active ingredient listed on one bag was the long chemical name for dicamba, and on a similar bag was the long chemical name for dichlorprop.

Pre-emergent herbicides (*e.g.*, pendimethalin, trifluralin, benfluralin, dithiopyr, and prodiamine) are applied to soil and are absorbed by root systems or by emerging shoot tips during germination. Most must be dissolved in moist soil to kill newly germinated seedlings.

A comparison of the abundant amounts of pendimethalin and trifluralin in every garden center in March and April, with a only a few garden centers having a sparse quantity of these products (Step-1) in June, suggests that these products sold early in the spring but were not restocked once the season for successful control of weeds with these chemicals had passed.

Selective post-emergent herbicides (*e.g.*, trimec; 2,4-D; mecoprop; dicamba; and dichlorprop) generally perform best at warmer air temperatures because the rate of uptake increases as temperature rises. These herbicides are generally most effective when applied to young plants, and several days may be required for the effects to be seen. These herbicides are effective against all types of broadleaf weeds, but are especially valued for controlling perennial weeds in lawns.

Low supplies of post-emergent herbicides (Step-2) in June, especially in popular family-owned garden centers (1, 2, and 3), might be the result of unanticipated demand by consumers who wished to control the many weeds that had germinated during the wet spring of 2002. Only one Step-4 fertilizer was reported.

The fact that Scott's Super Winterizer Plus Weed Control was not given on the preliminary list undoubtedly contributed to the fact that no one reported this product in June. But other factors should be considered to explain why only one late-season fertilizer with broadleaf weed control was found. June may have been too early for some garden centers to accept delivery of Step-4 weed-and-feed products. Another plausible explanation is that the Step-2 weed-and-feed fertilizers are also sold for controlling late-season lawn weeds.

This survey did not evaluate formulations of post-emergent broadleaf herbicides used for spot removal of a few isolated weeds from lawns.

Both moles and slugs may significantly damage valued plants. Therefore, many

manufacturers have created products for controlling populations of these pests. Controls for moles ranged from biological and chemical poisons to smoke bombs, mechanical traps, and even sonic devices.

Many products sold for slug control are the widely available baits containing metaldehyde alone or combined with carbaryl (Sevin®). However, three brands containing iron phosphate or aluminum phosphate were found at family-owned garden centers, and these substances can be used safely around domestic animals and wildlife.

Our experience in gathering pesticide information from Internet resources and by contacting individual manufacturers for *BYGL* may be of interest to other groups who wish to do a pesticide survey. Unfortunately, searching the Pesticide Action Network Database at **http//www.pesticideinfo.org/** and the web sites of individual manufacturers for pesticides found in the three local family-owned garden centers (February 2002) proved to be of limited value.

One problem with Internet searches for pesticides was that some web sites provided only a little information about a few products in the entire line a manufacturer produces for homeowner use, whereas other web sites listed all pesticides the company had ever manufactured, even those no longer licensed for homeowner use.

One MG contacted an employee at The Scott's Company and was able to obtain a list of Scott's and Ortho products currently licensed for homeowner use, along with the active ingredients and formulation. Another MG contacted Bayer, Bonide, and Voluntary Purchasing Group, Inc., (Fertilome) and obtained similar information from these companies. These four lists were very useful for sketching a template for recording what pesticide products would likely be available and where these products might be located within retail outlets.

Acknowledgements

Special thanks are extended to the nine Master Gardeners who completed the pesticide surveys at the 10 garden centers. They are Karen Demboski, Marilyn Golightly, Debbie House-Cohen, Barbara Merritt, Theresa Merva-Sico, Dorothy Pettenski, Jeanne Sutton, Lynne Sutton, and Juliet Taylor. This truly was a team effort, and the cheerfulness and attention to detail of all is greatly appreciated.

Much appreciation is extended to the managers of the retail outlets who permitted MGs to search for pesticide information in their stores and generously helped find products.

Also, gratitude is expressed to the various employees of the garden centers who helped the MGs pursue pesticide information for this survey.

Where trade names are used, no discrimination is intended and no endorsement by Ohio State University Extension is implied.

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Tree Selection for Survivability: Trees That You Should Know

Kenneth D. Cochran

Matching Desired Trees To Appropriate Planting Locations

Trees can be planted and cared for to create and maintain a diverse, natural landscape system and to provide numerous functional and aesthetic benefits such as shade, shelter, and beauty. Most people consider trees among the most valuable assets of our environment, and plant selection is a key component to the survivability of plants in the landscape.

Following a November 2003 tornado through portions of Wayne County, Ohio, the effect of fallen trees was sadly apparent. It was disheartening to lose years of growth in just 10 minutes of turbulent, high-velocity winds. And added to this dismay, trees cost money — to grow, to plant, to maintain, and to remove.

The Ohio Agricultural Research and Development Center's Secrest Arboretum in Wooster, Ohio, has done a lot of tree selection evaluation work over the years in order to help research scientists, educators, students, producers, landscape designers and architects, retailers, and consumers make wise decisions about which trees to select for a particular landscape. It is important to match desired trees to appropriate planting locations.

In most landscapes, the loss of trees calls for replacement in order to return the landscape to a diverse natural system. Landscapes that need tree replacements should be analyzed individually before a decision is made as to which tree or trees to plant. Responsible relationships should be assessed between plants, people, and the environment, following an investigation of personal needs, soil and environmental conditions, and the review of various species and cultivars for the landscape situation in question.

Considerations at Stake

Do certain trees grow in restricted and disturbed soil environments? Do certain trees withstand the assault of salt spray in winter? Do they withstand soil compaction, which reduces the macropore spaces and reduces the entry of oxygen and water into the soil mass? These are some of the questions that need to be assessed in a people/plant/environmental relationship.

Some species are native to river flood plains and can grow with reduced oxygen levels when the macropores are filled with water for long periods.

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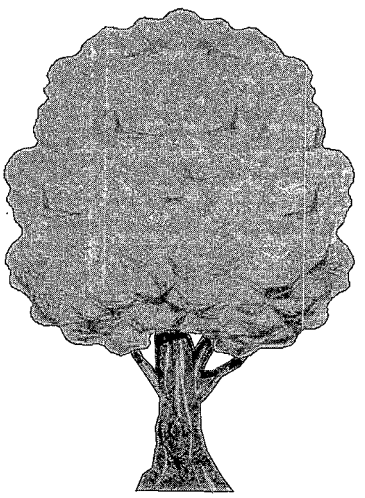
Atmospheric temperatures affect plant growth to varying degrees depending upon species or cultivar selection. Temperatures several degrees warmer or colder than are characteristic of a season, affect species and cultivars differently. A common stress factor of some plants is the predisposition to insect and disease attack under periods of higher temperatures.

The species red maple *(Acer rubrum)* and the European and Asian white bark birches *(Betula pendula* and *Betula platyphylla)* are examples of plants that have limited tolerance to periods of unseasonably high temperatures, while in OARDC studies, the American white bark birch *(Betula papyrifera)* has proven more heat tolerant.



Low-temperature tolerance or cold hardiness may also vary within the species *Acer rubrum* and its cultivars. The Shade Tree Evaluation Project, as it was originally named at OARDC's Secrest Arboretum, illustrated the cold hardiness of a cultivar of American sweetgum, *Liquidambar styraciflua* 'Moraine,' relative to other sweetgums, during the low-temperature winter of 1976-77.

The Shade Tree Evaluation Project also illustrated the lack of cold hardiness in the hybrid sycamore, *Platanus* x *acerifolia,* in which cankers formed on tree trunks and severely injured trees in replicated studies at Wooster.

High winds and particularly channelized winds such as tornados are potentially seriously damaging to some species of trees. While some of these effects are apparent after the fact, it has been determined that some selections such as *Pyrus calleryana* 'Bradford' will have more severe branch breakage even under moderate winds.

In fact, scaffold branches of 'Bradford' were severely broken under wind, snow, or ice loads over the years on all eight randomly replicated trees at the Wooster trials to the degree of destroying the tree structure. Moreover, on the OARDC'S Wooster campus, the scaffold branch structure of 'Bradford' was destroyed on some trees to the degree that necessitated tree removal just due to the weight of foliage and fruit without the interception of high winds.

Trees develop restricted root systems and are stressed when planted within certain restricted soil zones and conditions, particularly in narrow tree lawns and in sidewalk cuts. Such soil volume may be limiting for effective root growth, water percolation, and as a storehouse for water reserves, in which case a tree may be affected by drought stress.

Combining the Conditions of a Landscape Site With Tree Selection

Plant survival is important to most people who plant and grow trees in their landscapes. Some landscape sites are not optimal for plant life. While some plants will survive under non-natural conditions better than others, the challenge of tree selection is critical in certain landscape situations.

Obtaining information about a species' ecological adaptation greatly helps in the selection of plants for landscape situations as well as the survivability of specific

After damaging trees, houses, and businesses near downtown Wooster, the November 2003 tornado tore up trees on this hill and then crossed Route 585 (shown in the background), causing major damage to one of the city's largest businesses. Wooster is a Tree City USA, and huge old trees in various locations throughout the city were torn in two, stripped of their branches, or uprooted by the devastating winds. The tornado also struck portions of Wayne County, damaging barns and other structures.

plants. For many landscape situations, it has been proved over and over that certain species and cultivar selections thrive and sustain plant health over others. Information about plant survivability and health in the urban environment needs to be continually updated because conditions continually change and existing plants age.

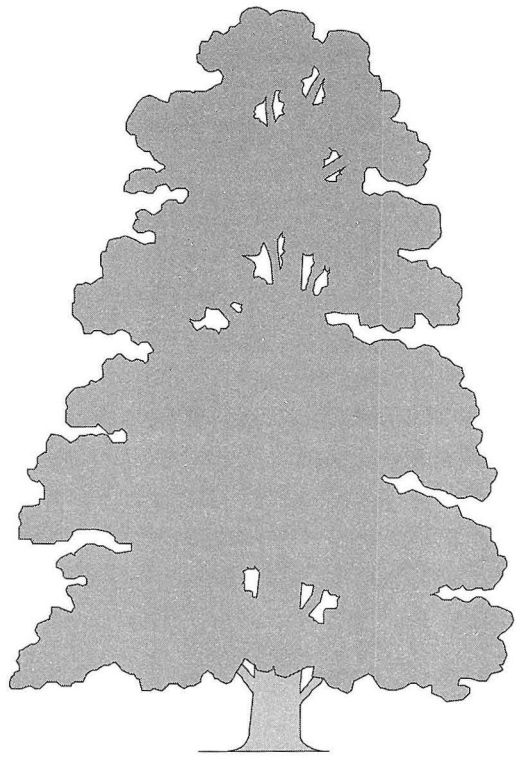
Although not a necessity, the beauty of ornamental features is highly desirable from a human perspective. The eventual height and spread designation of a plant helps in choosing selections for special size requirements. Cultivars should be recommended over species when certain desired traits are identified for those cultivars.

Tree evaluations in OARDC'S Secrest Arboretum have been designed so as to conduct an unbiased scientific evaluation of trees in replicated and randomized plots. Several trees mentioned in this article can be found in the Deciduous Tree Evaluation Project in the Arboretum, USDA Cold Hardiness Zone 5b.

The intention of this writing is not to mention all trees suitable for landscape planting, but to bring to attention of consumers and producers a diverse sampling of proven selections for various Ohio growing conditions and to help people make plant selection decisions that will maximize value in people/plant/environmental relationships.

Tapping into Deciduous Tree Selections That Consistently Rank as Good Landscape Investments

Acer rubrum (red maple) is a species noted for its ability to withstand moist, poorly drained sites, but not soils that readily dry during the heat and drought of summer. Maples are a popular tree, and there has been interest in selecting superior types of red maple for good red autumn foliage, such as 'Red Sunset' and 'Autumn Flame.' The cultivar 'Columnare' has withstood heat and drought very well in Wooster studies.



A Dutch nurseryman visiting the Secrest evaluations requested propagation material of this selection because in his estimation, 'Columnare' was the best cultivar in the evaluation. The hybrid maple, cross of red and silver maple, *Acer* x *freemanii* 'Jeffersred,' Autumn Blaze® flourishes under hot and cold climates, and in the Secrest Arboretum it has been consistently attractive in autumn (see *Green Times,* Vol. VI, No. 2/3, "Riotous color: Maples and autumn foliage").

Betula nigra (river birch) adapts to poorly drained soil conditions and is native to river-bottom areas. Leaf miners can cause cosmetic foliage damage, but bronze birch borers or diseases do not limit the use of this species. An 11-year-old plant of the spreading selection Fox Valley® is 6 feet in height and spread in Secrest Arboretum and is an eye-catcher. Its habit is uniform, compact, and densely branched from the ground; it is adaptable to poorly aerated soil conditions, and the ornamental feature of colorful patterns of cinnamon-red and pale-salmon exfoliating bark on main branches becomes evident at an early age. Surely there is an appropriate small-scale site in the landscape for Fox Valley®.

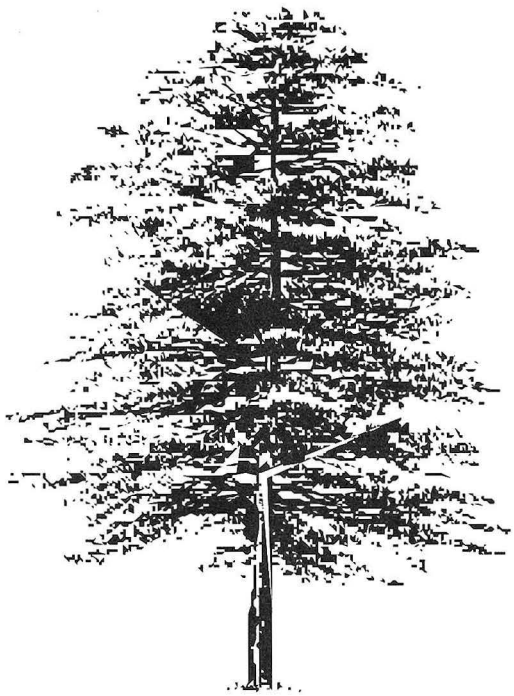
Three excellent disease- and insect-resistant species with tolerance to the dry soil conditions of the urban landscape are *Carpinus caroliniana* (American hornbeam, ironwood); *Ginkgo biloba* (maidenhairtree), with male selections such as 'Autumn Gold' and 'Lakeview;' and *Gymnocladus dioicus* (Kentucky coffeetree), another North American native.

Total aesthetic ratings of crabapples have been continuously evaluated at Secrest Arboretum from 1993 to the present. Consider crabapple selections by referring to *Ornamental Plants, Annual Reports and Research Reviews, 2002,* Special Circular 189, The Ohio State University, Ohio Agricultural Research and Development Center.

Among *Quercus* (oaks), there are several excellent species that are long-lived and have performed well in urban environments. *Quercus macrocarpa* (bur oak) is a wide spreading tree more tolerant of drought than some oak species. *Quercus shumardii* (Shumard oak) has a good growth rate in average soil conditions, even soils with high pH. *Quercus*

muehlenbergii (chinkapin oak) is found in its native Ohio habitat on dry alkaline soils and in fertile bottomland (see *Green Times,* Vol. V, No. 2/3, "How Mighty Is the Oak").

The species *Celtis occidentalis* (common hackberry), while not extensively evaluated at Wooster, is adaptable to many environments, even tolerant of harsh climates. The cultivars 'Prairie Pride,' 'Chicagoland,' and 'Windy City' are resistant to the witches' broom disease that tends to occur on the species. The species is adaptable in its tolerance to soil-moisture stresses, with adaptability to poorly drained soils as well as a tolerance of dry soils.



Consider trees that mature to 20 to 30 feet in height for small spaces or in some cases as understory plantings. A small tree with cinnamon-brown peeling, showy bark and reddish-bronze autumn foliage is *Acer griseum* (paperbark maple).

Consider the genus that signals spring and has year-round interest when grown in full sun or partial shade — *Amelanchier* (serviceberry) and cultivars of *Amelanchier arborea, A. canadensis, A. laevis,* and *A.* x *grandiflora* with 'Autumn Brilliance' being true to its name.

Cornus alternifolia (pagoda dogwood) is a small, tiered, horizontally branched tree for a strong planar positioning. It is at home when planted in a cool, understory environment, where it develops its full potential when protected from excessive sun.

A grand and noble tree is *Tilia tomentosa* (silver linden), native to southeastern Europe and western Asia, but adaptable to Ohio in terms of varied temperature and moisture tolerance. It is potentially a large tree with heat and drought tolerance, and the sweetly fragrant flowers enhance the air in early summer. The Ohio native species *Tilia americana* (American linden) is a good Midwestern lawn tree and the cultivar 'Redmond' has grown well in Wooster trials.

The monoculture of *Ulmus americana* (American elm) in the early decades of the 20th century taught the importance of species diversity in planting trees in our cities and towns. Elm tree hybridization by the USDA Nursery Crops Research Laboratory, Delaware, Ohio, followed the death of millions of American elms from Dutch elm disease.

Three of these hybrid cultivars have been evaluated in Secrest Arboretum. 'Urban,' 'Homestead,' and 'Pioneer' have proved to be tolerant of the stresses of varied soil conditions, poorly drained or dry and compact soils, and have had rapid growth. No Dutch elm disease has occurred in more than 30 years of evaluations at Secrest, but cosmetic insect problems have occurred.

In Conclusion

For more information:

- Read *Ohio Trees*, by T. Davis Sydnor and William E. Cowen on the web at:

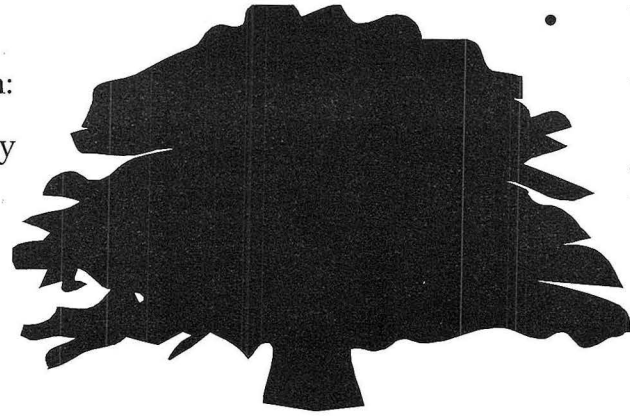
  http://ohioline.osu.edu/b700/index.htm

  Ohio Trees is also available through local Ohio State University Extension offices.

- Attend Tour de Trees at Secrest Arboretum on Tuesday, March 23, 2004, from 1 p.m. to 3 p.m.

- Subscribe to *Green Times*, a publication of Secrest Arboretum.

- Join the Friends of Secrest Arboretum.



- Visit our web site at:

  www.secrest.osu.edu

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10 Crabapples to Know, Show, and Grow

Erik A. Draper, James A. Chatfield, and Kenneth D. Cochran

When asked to give recommendations for which crabapples to use in a given landscape situation, the authors' responses are typically: "Let's start with 10 and go from there!"

The 10 crabapples discussed here were selected after holding vigorous discussions and arguing their merits in the Crablandia II plot at Secrest Arboretum, in Wooster, Ohio, at The Ohio State University's Ohio Agricultural Research and Development Center. These discussions were usually terminated either by a lack of light left in the sky or by the lack of ammunition necessary to finish an excellent crabapple fight.

All of these taxa can be viewed any time of the year at the Crablandia II plot. We encourage all to do so to better evaluate which one or ones will best fit into any given landscape setting.

These crabapples are part of an ongoing research study evaluating disease susceptibility and overall aesthetic profiles of these trees. The plot was initiated in 1998 with 63 taxa. Currently, there are 68 taxa planted and being evaluated.

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The plot design is completely randomized with five single plant replications of each taxon, and the plot is evaluated monthly. The plot will continue to increase in number of taxa with new releases or selections until 80 taxa are planted, thereby filling the allotted space.

The crabapples listed here are in alphabetical order and are not placed in any order of preference or performance. All of these crabapples are impressive in bloom and in fruit or in form, have good to outstanding resistance to apple scab disease, and are worthy landscape assets. We hope that you enjoy watching these trees grow and show their "colors" as much as we do — and keep in mind — the 10 profiled here are just the beginning.

Note: Crabapples are *Malus* taxa with fruits less than two inches in diameter at maturity. Most ornamental crabapples are within the 1/2- to 3/4-inch-diameter range.

'Adirondack'

Positives: Oblong, orange-red fruits are impressive from late August through mid-December. Showy white flowers with a pleasing narrow or tight, V-shaped upright tree form; great autumn fruit/foliage combination; fruit ripens to a deep orange-red; fruit appears singular rather than clustered; flowers are abundant and red-tinged.

Negatives: Somewhat slow to establish, and leafhoppers appear to relish the foliage but do little damage.

Diseases: No scab; trace of fireblight. There are not many upright crabapples without serious flaws, but 'Adirondack' not only is without such serious flaws, but also is a truly outstanding ornamental crabapple.

Malus baccata 'Jackii'

Positives: Maroon-red fruits color up by late July and are highly effective ornamentally until mid-December. Lightly scented white flowers accent the large, fast growing, broadly rounded tree form. Very reliable yearly flower display; large, glossy green leaves are by far the best foliage of any crabapple in the plot; fall contrast of yellow- and rust-colored leaves against attractive maroon-red fruit is outstanding; bark develops an attractive orange cast with age.

Negatives: Relative sparseness of fruit clusters and mediocre overall winter appearance.

Diseases: No scab.

'Excalibur'*

Positives: Tiny, golden-yellow, shiny fruits are outstanding from mid-September to mid-December. Petite, white flowers line branches on this 8-foot dwarf, globe-type tree form. Fruit-lined branches create striking specimen in the landscape, with fruits maturing to an aesthetically pleasing shiny, cider-brown color.

Negatives: Flowers can be hidden by rapidly expanding foliage; fruit is hidden on the plant interior until leaves drop.

Diseases: No scab; apple mosaic virus noted.

* If unavailable, try another fabulous yellow-gold fruited alternative crabapple called 'Bob White.'

'Holiday Gold'

Positives: Clusters of golden-yellow fruits line the branches, effective from late September to late March. Impressive clusters of white blooms are consistent, excellent performers each year on a somewhat rounded, open tree form. One of the best new, yellow-fruited crabapples; fruits an attractive cream-yellow mellowing to deep gold-yellow; nice rose blush can develop on exposed fruit.

Negatives: Tree form can become awkward due to repeated fruit loads.

Diseases: No scab; trace of fireblight.

'Firebird'**

Positives: Very small, red-orange fruits are dispersed along the branches from late September to early January. Tiny, white flowers accent the upright vase tree form. Due to top-grafting, the unique shape is consistent and perfect for size-restricted spaces.

Negatives: Slow to establish and grow; flower and fruit displays are scattered and steady but never dazzling.

Diseases: No scab.

** If unavailable, try another excellent high grafted tiny, red-fruited alternative unique crabapple called 'Lollipop.'

'Louisa'

Positives: Scattered lemon-gold fruits are noticeable late July to mid-November. Outstanding pink flowers enhance a true weeping tree form. Tree form is a glorious asset with arching, graceful branches

upswept at tips; fruit darkens to a gold-orange with a tan-brown blush.

Negatives: Fruit set is light and scattered, never profuse.

Diseases: No scab. Though there are a number of outstanding spreading-weeper crabapples, such as 'Manbeck's Weeper,' 'Molten Lava,' 'Mary Potter,' and 'Candymint,' 'Louisa' is a rare true weeping crabapple.

'Prairifire'

Positives: Purple-red fruits are easily the first to be noticed in late June and are ornamental until early December. Striking coral-red flowers seem to fill the rounded, open tree form. Yearly spectacular bloom contrasts emerging red-tinged green foliage; firm purplish fruits slowly age to cherry red; fall color of orangish spur leaves contrasts well with fruits and other foliage; attractive lenticel-speckled bark.

Negatives: Mediocre winter and early summer appearance.

Diseases: Trace of scab for past three years, yet completely scab-free other years.

'Red Jewel'

Positives: Sparkling cherry-red fruits light up in early September and remain impressive into mid-April. Snow-white flowers outline the upright open tree form. Phenomenal firm fruits are very appealing well into spring; attractive blooms.

Negatives: Mediocre tree form noticeable in late winter to early spring; slow-growing tree; tree form a bit awkward.

Diseases: Trace of scab just in 2000; some fireblight problems.

'Strawberry Parfait'

Positives: Red-cream fruits color up and create an impact from starting in mid-August with colors darkening through the fall and winter to mid-April. Rounded pink-red flowers appear to entirely encompass each branch on this uniquely shaped, open, spreading tree form. Fruits age to deep red; newly emerged foliage is a burgundy becoming green with burgundy-tinge; good fall color; fruits remain firm through late winter.

Negatives: Fruit mummies can be tenacious; unusual, erratic, upright-spreading growth habit is not for every landscape.

Diseases: Trace of scab.

'Sugar Tyme'

Positives: Brilliant red fruits provide color in early September and remain until mid-April. Stunning sugar-white floral display from pale pink buds on a mounded spreading tree form. Showy, persistent, firm fruits create interest through late winter; good overall form; dense foliage.

Negatives: Mediocre appearance during summer before fruits color; foliage appears chlorotic or off-color during mid- to late summer; yellow-brown frost rings develop on fruits in some years.

Diseases: Trace of scab.

So, that's it — 10 magical *Malus* you should know. We added a few alternatives in the text above, and we can think of many more, such as a number of variants of the Sargent crabapple, and then....Well, wait 'til next year.

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20 Questions of Pruning

Larry G. Steward

No matter how far we advance in the horticulture industry in dealing with the various aspects of plant care, we need to be reminded of the basics. This article reviews the basics of pruning woody plants.

Pruning of trees and shrubs should be a regular part of the holistic approach to plant care. It involves the selective removal of specific plant parts, which may be dead wood, shoots, or branches and can involve removal of roots, flower buds, spent flowers, fruits, and seeds.

Although pruning can be defined simply as the selective removal of plant parts, there is more to be considered. That is the basis for the 20 questions of pruning.

1. What is the plant to be pruned?

Without knowing the exact genus or species of a plant, improper techniques may be used during the pruning process. For example, pruning of pines is only done during the time of development of the new growth or *candles*. Yet many other conifers can be pruned at any time of the year. Pruning of pines at any other time during the year can result in die back and eventual death of branches.

Another example of needing to know the genus involves palms. A person needs to know the difference between a woody tree and a palm tree. Pruning and thinning a palm tree in the same fashion as a woody shade tree would result in death of the growth crown of the palm.

Further, just knowing the genus may not be enough. With hydrangeas as an example, the species commonly known as large leaf hydrangea *(Hydrangea macrophylla), e.g.*, the 'Nikko Blue' cultivar, can be pruned in the spring and not affect flowering. This plant flowers on new wood. Yet another species, oakleaf *(Hydrangea quercifolia)* sets its flower buds in late summer during the previous year. Pruning them in the spring would remove flower buds from that year.

2. What is the natural habit of growth of the plant to be pruned?

Is the pruning process an attempt to make the shrub or tree into something it cannot be? A spreading shrub is not going to become an upright or columnar plant through pruning.

This also leads to the possibility that the plant is the wrong plant for the location or that the plant is planted too close to an entrance, walk, street, or another plant. It may be possible that the only solution to the pruning dilemma is total removal of the plant and installation of another more suitable plant for the location.

An excellent example would be trying to use English ivy as a groundcover among

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other shrubs and next to a building. A choice of another groundcover plant would save almost unending pruning and potential damage to the other plants and the building. English ivy grows very vigorously, sometimes as much as 20 feet per year. The plant may then grow over other plants, shading them and preventing sunlight from reaching anything but the ivy.

The other problem with English ivy is its method of attaching itself to structures for climbing. This ivy forms roots at every leaf node, roots that penetrate into whatever it is climbing. This includes mortar, concrete, brick, and bark.

As English ivy plants and their roots grow, the roots expand and cause these materials to crack and break up. Long-term growth of English ivy on buildings can cause actual destruction of the structure.

3. Where is the plant growing?

The type of pruning can be affected by the location. A formal type of pruning or a crown thinning would not be used on shrubs and trees that were planted as a screen on an industrial site.

Further, root pruning would not be done to shrubs planted for the purpose of erosion control. The pruning methods and practices need to match the purpose for which the plants are placed in the landscape.

Also laws and regulations may affect the pruning of the plant and its location. For example, a plant may be blocking the visibility of traffic regulatory signs.

Plants may have to be pruned to meet the requirements of the Americans with Disabilities Act (ADA). This brings about the consideration that the actual pruning may be total removal of the plant and/or replacing it with a plant with a more suitable habit of growth for the site.

4. What is the purpose for pruning the plant?

Pruning may be done to reduce plant size to make it fuller and denser, to make it spread, or to make a plant more upright. Pruning may be nothing more than an effort to improve the plant's shape or habit or to create special shapes and forms such as espalier or standards.

Pruning is done to train young plants, or it can be done to rejuvenate "elderly" plant material already in the landscape. This rejuvenation can be done in the case of shrubs by removing a fourth of the stems or by cutting the plant to within inches of the ground. Knowing what the best practice is relates to question No. 1 — what is the plant?

Proper pruning techniques can be used to increase or decrease flowering. One may want more flowers for the beauty of the plant, or fewer flowers may be desired in order to produce less fruit.

Pruning must be done to prevent damage to personal property, such as preventing branches from dropping on vehicles and buildings. An example of pruning to prevent property damage would be to keep English ivy cut back to prevent it from destroying mortar in a brick building.

Finally, the law may require pruning. In the case of the Americans with Disabilities Act, there must be enough clearance above and next to walkways so as to avoid a barrier to users of the walkways and steps.

Trees that are growing into streets and highways become visual and physical barriers, raising legal issues.

5. What does the client want?

The client may want the plant to be beautiful, or to fit into a location, or simply to be healthy. Knowing the plant and its requirements becomes very important in determining whether these requests can be met.

Sometimes client expectations are unreasonable, which means that the pruner has the opportunity to be an educator. A plant that has a very high sentimental value but has lived its full expected life cannot be made healthy by pruning.

Further, a plant that is not suited for its location due to size, shape, or natural environment cannot be made to fit by pruning. Pruning is not the solution to poor selection originally, and the sometimes unreasonable expectations for a pruning fix need to be professionally addressed prior to starting the job.

6. What is the present health of the plant?

Is the plant healthy enough to withstand the "shock" of pruning? It may be that the pruning of a weakened plant may be the final blow that leads to its death if there is not enough vigor. Pruning may actually remove the plant's ability to adequately photosynthesize and thus bring about decline and eventual death.

The person may also spread disease, causing pathogens from a diseased plant to spread to healthy plants unintentionally. The plant to be pruned could be infected with pathogens that are easily transferred on the pruning equipment.

7. Will the plant be healthier when pruning is completed?

It is possible that the pruning can actually make the health of the plant worse, rather than improve the plant's health. An example would be pruning a crabapple infected with fireblight. As a result of pruning, the pathogens could be spread to healthy parts of that plant or spread to other healthy plants.

Another possibility could be the thinning of a shade tree. This would open shaded branches to sunlight, providing the proper conditions and environment for sun scald and eventual decline of the upper branches. This commonly happens with crown thinning of maples such as sugar maple and Norway maple.

Heavy amounts of pruning can initiate an abundance of suckering. These suckers, being generally quite succulent, are easily attacked by pathogens and pests, thus causing the possibility for plant decline. Further, if the plant is in a state of decline at the time of pruning, wounds may not compartmentalize properly. This presents another opportunity for insect and pathogen entry into the plant.

Sometimes the only economical recourse is complete plant removal and replacement. Otherwise, the resulting plant, after pruning, may not be of any landscape value or may become even more costly to maintain due to having to control disease, pests, or other forms of decline.

8. Is it the proper time to prune?

Many factors can affect the timing of pruning. These factors include temperature extremes, moisture and humidity extremes, time of day and year, and when the flower buds are set.

With temperature, pruning when the temperature is too cold can result in the death of the living cells in the vascular cambium, thus slowing callusing and closing of the wound. With the opposite extreme of high temperatures, excessive

transpiration can slow closing of the wounds due to sap flow or the drying of surface cells in the vascular cambium. This factor is aggravated or enhanced with low humidity and drought conditions. High humidity and plenty of moisture in the soil are the best conditions for pruning.

Even time of day can affect the plant's response to pruning. In the morning when temperatures are cool and the plant is turgid, there is less adverse effect to the plant.

Time of the year also comes into play relative to plant response. For example, pruning a pine at any other time than when the candle growth is immature may result in eventual death of branches. Pruning of plants in early spring encourages new growth, while pruning in mid-summer controls new growth. Pruning too late in the summer can encourage new growth on the plant, risking freezing injury.

Further, if the plant is used in the landscape for the benefit of its flowering, one needs to know when the flower buds are set. Most plants flowering in spring to early summer will set the flower buds the previous summer and fall. These plants need to be pruned within weeks after flowering in order not to remove next year's flowers.

Most plants that flower in late summer to fall set buds on new growth as it develops. Pruning these plants in the spring will not affect the flowering. A good rule of thumb on flowering woody plants is to prune immediately after they flower. One is least likely to have a loss of the flowering by following this rule of thumb. This also ties in with question No. 1 — what is the plant?

9. When does it flower?

This refers back to knowing what the plant is and the purpose for which it is being used in the landscape. As discussed under question No. 8, it is important to know when buds are set on the plant to be pruned. However, "pruning immediately after the plant flowers" does not mean the very next day after the petals fall. Typically, there is a period of up to six weeks during which pruning can be done without loss of flowering the following year. This period of time can be shortened due to high temperatures and low humidity, causing the buds to mature quicker.

10. Is the proper pruning equipment available?

What equipment is needed to do a "proper" pruning job? The minimum requirement for necessary tools is a hand pruner and a pruning saw. The hand pruner should be a bypass type of cutting blade for more precise and less damaging cuts. A hand pruner should not be used to cut branches larger than 1/2 inch in diameter to prevent damage to the pruners. See Figure 1.

The pruning saw comes in many shapes, sizes, and teeth configuration. Pruning saws are all different from the basic carpenter's saw in that pruning saws cut by being pulled through the cut while carpenter's saws cut by pushing through the cut. Earlier pruning saws had varying size teeth and a *set* to cut down on drag, remove sawdust from the cut, and to allow the blade to continue cutting through the cut.

Newer pruning saws have little or no *set* as the back of the saw blade is thinner than the blade area. These saws also cut in either direction due to the configuration of the teeth. See Figure 2.

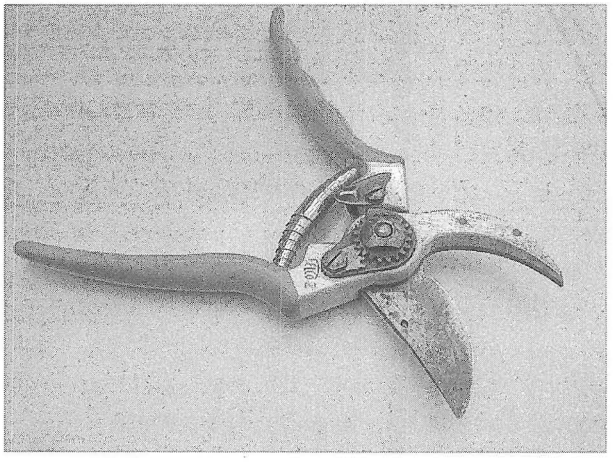

Figure 1. A hand pruner with a bypass type of cutting blade. This pruner should not be used to cut branches larger than 1/2" in diameter.

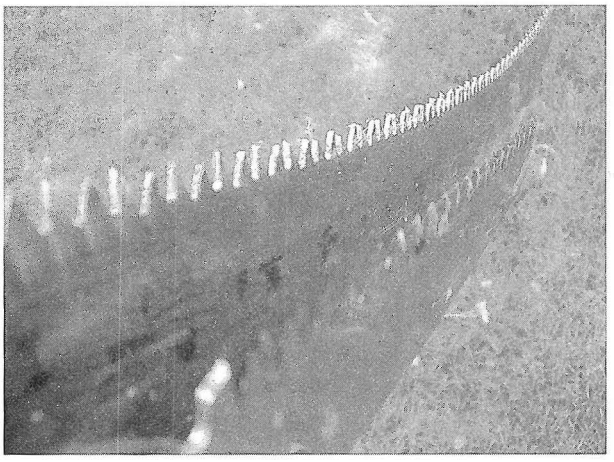

Figure 2. Newer pruning saws have little or no "set" as the back of the saw blade is thinner than the blade area. These saws also cut in either direction due to the configuration of the teeth.

Another pruning tool that can be used is loppers for the in-between size branches ranging from 1/2 inch to 1-1/2 inch in diameter. Pole saws and pole pruners are used to extend the operator's reach without using a ladder or climbing into the tree. Finally, the powered chainsaw, typically used for branches more than 4 inches in diameter or for total removal of the plant, is sometimes required.

11. Is the pruning equipment sharp?

Sharp tools are essential for proper pruning. Pruning with dull equipment causes tearing of the wounds, rough and jagged cuts, and poor wound closing. Poor wound closing allows pathogens and insects to enter. The ultimate result of this can be damage or loss of the plant that is pruned.

Furthermore, using dull tools is harder, more tiring, and more work for the person doing the pruning.

12. Is the pruning equipment sanitary?

When was the last time that the saw or the pruners were sanitized? If the purpose of pruning is to remove diseased branches, are the pathogens of that disease being spread by pruning?

Many times the person doing the pruning is the plant's worse enemy as far as spreading disease organisms. Fungi and bacteria are commonly spread by pruning equipment.

Chlorox and alcohol solutions are easy to mix and use. A Chlorox solution should be in a 1 to 10 proportion, while alcohol can be used in a 100% solution. Placing the pruning tools into the solutions between plants will prevent passing the disease organisms from plant to plant.

Sanitizing the saw or the pruners does add time to the pruning process, but, as a professional, one should be improving the plants through pruning, not making the problem worse.

One caution with the use of a Chlorox solution is that the person doing the pruning should be prepared to lubricate the hand pruners and loppers regularly as this solution will corrode the tools. A

light oil put on the pruners daily will help prevent this from happening. It may mean that the pruners should be disassembled and coated with oil on a weekly basis to prevent corrosion in the moving parts of the pruners.

13. What obstacles are in the area?

Always be aware of the surroundings when pruning. It is critical when pruning trees and often even when pruning shrubs. Some of the obstacles to be aware of in the area are utilities, above and below the ground surface; other plants; children, pets, and their toys; wildlife; vehicles and buildings.

The non-moving obstacles are generally quite visible before starting to prune, but the person doing the pruning will always attract an audience. This audience may be adults, children, or pets who move into the area after work starts.

14. What is pruned out first, second, and third?

Once the plants to be pruned are known, the purpose for pruning decided, the proper tools selected, and the area cleared, it is time to start the actual pruning process. The first materials removed from the plant are the dead branches. This is commonly classified as *dead-wooding.*

Secondly, the next plant parts to be removed are any diseased branches or insect-damaged branches. Be sure to sanitize the pruners when doing this pruning. Also included in this group of pruning material would be any hazardous, hanging broken branches.

The third step in pruning is to remove any crossing and or rubbing branches. This pruning step in tree pruning could be classified as crown thinning. These wounds on the branches, over time, become hazardous or become an entry for pathogens and insects. .

15. How are the large branches removed?

Larger branches are removed by a three-cut procedure. This prevents tearing back of the bark which would offer easy entry to pathogens and insects. Further, the three-cut procedure improves and speeds wound closing.

The first cut is on the lower side of the branch to be removed. This cut is at least six inches from the trunk or the connecting branch. This cut is no deeper than half way through the branch to prevent pinching of the saw. This is illustrated in Figure 3.

The second cut is made on the upper side of the branch, two to four inches beyond the first cut and toward the end of the branch to be removed. This allows the branch to be cut off without pinching the saw or tearing the bark back to the trunk. See Figure 4 (top photo).

The third cut is then the removal of the remaining stub to the proper distance from the trunk or connecting branch. This is illustrated in Figure 5.

16. Where are the branches removed?

As illustrated in Figure 5, the branch is removed at what is called the *branch collar.* This is the swollen area at the base of the branch where it attaches to the trunk or to another branch. The branch that is removed is also cut at a 45- to 60-degree angle to the branch bark ridge. The purpose of cutting at these locations is to provide the best potential for wound closing and the least chance of pest entry.

Tree paint is no longer recommended to seal wounds as the environment behind the paint becomes ideal for decay

Figure 3. A three-step process is used to remove larger branches. This prevents tearing of the bark which allows easy entry for pathogens and insects. It also speeds wound closing. The first cut is made 6 inches from the trunk (or a connecting branch) and on the lower side. This cut is no deeper than half-way through the branch.

organisms. This results in loss of structural continuity and integrity.

Pruning of smaller branches that do not require a pruning saw should be done with as much care as with larger branches. Smaller branches are cut with an angle cut approximately 1/4 inch beyond the bud or node. Do not leave long stubs that become entry points for disease organisms. However, do not cut so close to the bud that as the bud develops into a new branch the point of attachment becomes weak.

Prune to a bud that will develop in the direction the plant is to be trained. For a plant that is to develop a spreading habit, the bud selected to prune to should be pointing outward from the plant. The opposite selection is done when slowing the spread of a plant and trying to develop vertical growth.

The person pruning should orient hand pruners or loppers to prevent leaving a stub.

17. What will the plant look like when it is finished?

The person pruning should have a mental picture of the desired appearance of the plant when it is finished. He or she should also know when he/she has reached the point of completion so the plant will look like this mental picture. If pruned

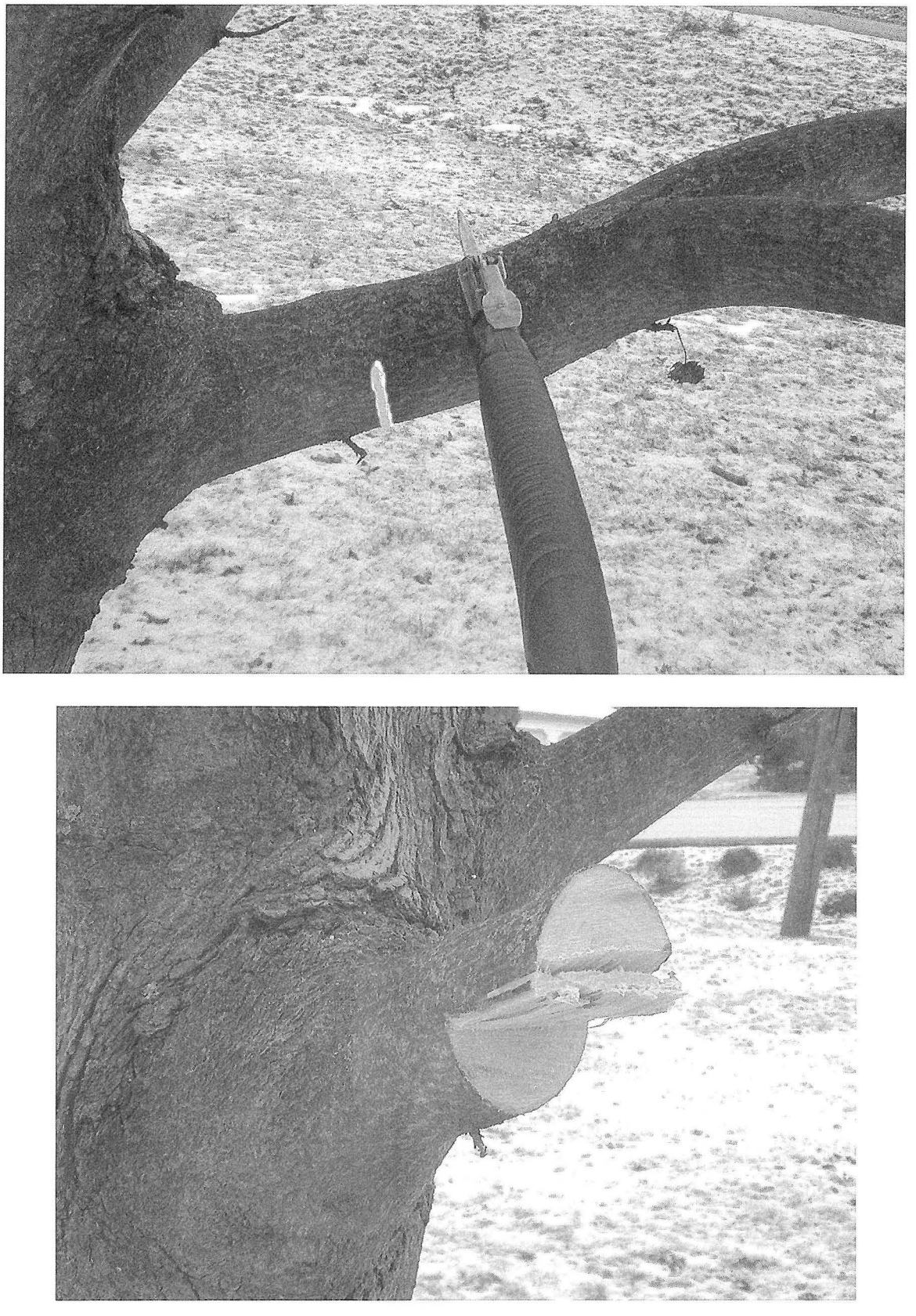

Figure 4. The second cut (top photo) is made on the upper side of the branch, two to four inches beyond the first cut and toward the end of the branch. This allows the branch to be cut off without pinching the saw and without tearing the bark. The bottom photo shows the tree after the second cut.

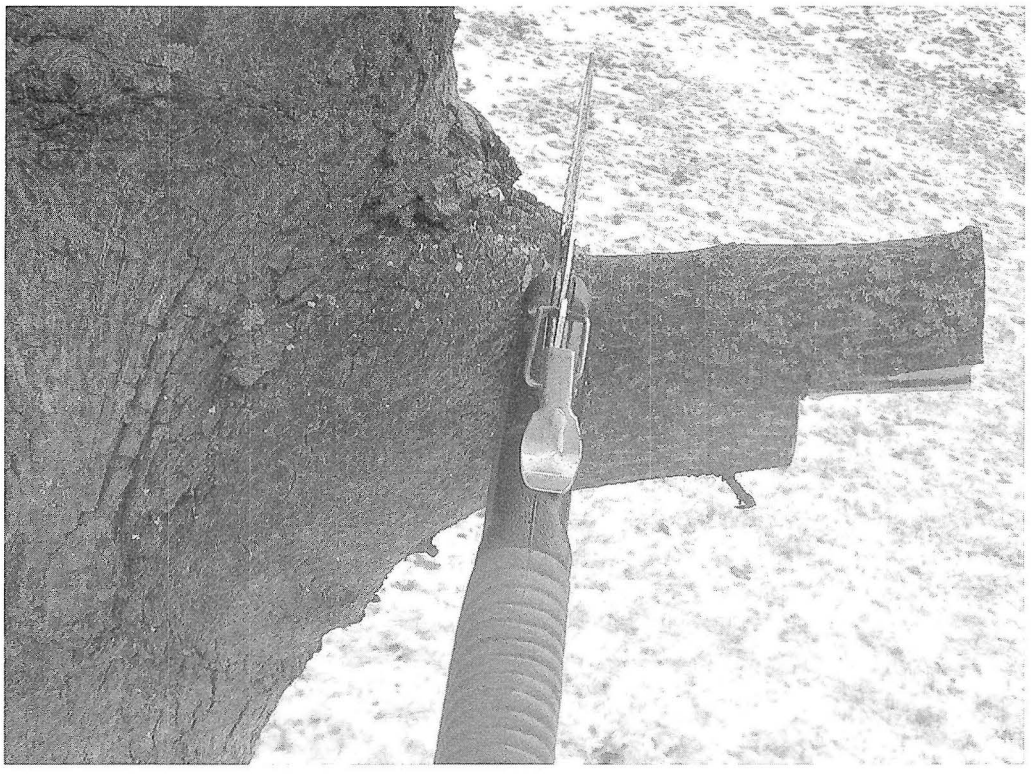

Figure 5. The third and final cut removes the remaining stub at the *branch collar*, the swollen area at the base where the branch attaches to the tree. This cut is made at a 45- to 60-degree angle to the branch bark ridge to allow for wound closing and to reduce the chance of pest entry.

correctly, the plant should not look as if it was heavily pruned. There should not be visible cuts, if at all possible. Foliage should be hiding most of the pruned areas.

18. What will the client see when the pruning is completed?

Unfortunately, if the person pruning has not explained and prepared the client prior to completion of the pruning process, the client may see the finished product differently than the pruner sees it. Success is when the client sees a well-shaped, healthy plant that does not scream out that it has been pruned. See Figure 6.

19. Will the plant "heal" its wounds?

Plants do not "heal" as animals do when wounded. Plants compartmentalize the wound or enclose and isolate the wound. Consequently, proper pruning techniques must be followed.

Proper pruning will result in callusing over of the wound on the outside as well as the inside. If this process does not take place, plants decay on the inside and become hollow. This may eventually result in the plant, especially trees, becoming hazardous.

20. Will the pruning have to be done again and how soon?

This depends on many factors. One factor is how extensive the pruning was in the first place.

Many times, severe pruning stimulates growth and suckering due to stored nutrient reserves. Many trees will be stimulated to send up long shoots from

Figure 6. Successful pruning results in a well-shaped, healthy plant that does not scream out that it has been pruned. And successful pruning produces a finished product that pleases both the client and the person who has done the pruning.

wounds and adventitious buds on old trunks. These will need to be removed to prevent the plant from producing unwanted branches.

The same is true if the plant is a fast-growing plant producing much growth each year. Pruning may be needed very soon after the initial pruning. An example of this would be privet. It is pruned as a hedge, and it seems that within weeks, the plant needs to be pruned again.

The season of the year can affect how soon the plant will re-grow. If pruned during the dormant period, re-growth is slow. Yet, pruning in early spring can bring on much new growth, and if thickening the plant was not the goal, it will be necessary to prune again.

In conclusion, pruning is not just a process of cutting branches when the mood hits a person. It should be a well-thought-out process. By asking these 20 questions prior to picking up the pruning equipment, one

may find that pruning is not the solution to the perceived problem in the first place. There may be other maintenance and environmental factors that must be taken into consideration.

Pruning is only one of many items in a holistic approach to plant care. Through following these 20 questions, one should achieve a plant that is well manicured, an asset to the landscape, providing benefits to the client and hopefully living a natural healthy life. Pruning of plants should improve the value of the plants and their environment, not degrade plant health and beauty.

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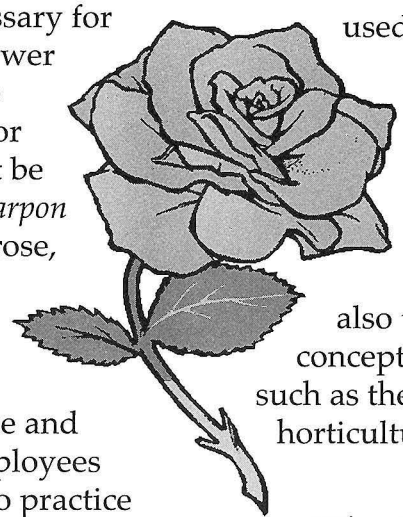
The Power of the Triangle

James A. Chatfield, Erik A. Draper, and Joseph F. Boggs

The disease triangle is a familiar concept to horticulturists who manage infectious plant diseases. It is the simple concept that infectious disease is a process, involving three facets — a virulent pathogen, a susceptible host plant, and an environment conducive to disease.

A standard test question for pesticide certification always lists these three and asks which of them is necessary for disease to develop. The answer is, of course, all three. If the disease is rose black spot, for disease to occur, there must be the fungal pathogen *Diplocarpon rosae*, a susceptible type of rose, and the right numbers of hours of leaf wetness.



The true power of the triangle, though, is to realize and train yourself and your employees to put this triangle truism to practice when considering how to control disease. For example, when considering how to control rose black spot, do not simply default to the squirt-gun botany solution of which fungicides are labeled. Broaden your consideration of all three facets of the triangle when deciding how to control black spot.

- Which roses have better genetic resistance to black spot?
- How can you limit the hours of leaf wetness by your choice of irrigation type and timing?
- How can you use sanitation to limit fungal inoculum in the planting?
- Finally, how can fungicides be best used to prevent infection?

Let's look at how we can harness the power of the triangle concept by looking at each facet of the triangle and using some specific diseases to illustrate the points. Let's also take a look at extending the concept, by looking at modifications such as the pest triangle, and finally — the horticultural triangle.

The Host Plant

Yogi Berra once said that "It ain't over till its over" and he might just as well have said, "A good place to start is at the beginning." The beginning for plant disease management is with proper plant selection.

Prevention is the key to disease control and, whenever possible, prevention starts with selecting plants with good genetic resistance to key disease problems. If you find yourself each year getting call after

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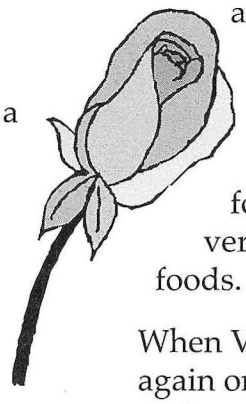
call about why the leaves are falling off the crabapples you installed and you are muttering that "it is the same darn thing over and over again," break the cycle.

Learn which crabapples in your part of the country have good genetic resistance to apple scab. Then combine this information with which crabapple fulfills your landscape design needs. Fortunately, with crabapples, there is a good collection of scab-resistant taxa over a wide spectrum of horticultural features.



Need an upright scab-resistant crabapple? Try 'Adirondack.' Need a spreading weeper? Try 'Manbeck's Weeper.' A true weeper with soft pink flowers? Try 'Louisa.' Wild and crazy growth habit which somehow still works? That's 'Strawberry Parfait.' Yellow fruits? Go for 'Holiday Gold.' Purple fruits? 'Prairifire.' Bright red fruits that persist well into winter? 'Red Jewel.' A Sargent type with pink flowers? 'Candymint.' How about something new with both apple scab and fireblight resistance? 'Royal Raindrops.'

It is also important to know what works in your area. Sometimes scab resistance is not a big factor in your part of the country. 'Royalty' and 'Radiant' are scab dogs in many areas, but where scab pressure is low and spring conditions are dry, these crabapples can be good choices.

It is also important to remember that disease resistance is not necessarily forever. While horticulturists are busily involved in plant breeding and in making superior selections, plant pathogens are also busily mutating and genetically recombining.

A rose that exhibits great genetic resistance to black spot in one part of the country or in times past may not do so elsewhere or over the years because of new strains of the pathogen that develop. 'Indian Magic' crabapple was listed with good scab resistance in the early days of the International Ornamental Crabapple Society trials; it now is listed as being quite susceptible.

This does not negate, however, the importance of first considering what your options are relative to host resistance. If horticultural desires mandate planting a 'Peace' rose even though it has susceptibility to rose black spot, at least do not choose all black-spot-susceptible roses for a public rose garden. Don't make it easy for *Diplocarpon rosae* to feast at a veritable training table of its favorite foods. Mix things up a bit.

When Verticillium wilt recurs again and again on your Japanese maples, switch to dogwoods or birches. When you grow weary of powdery mildew on your beebalms and zinnias, consider planting the 'Petite Delight' series of beebalm and the 'Profusion' series of zinnias.

The Pathogen

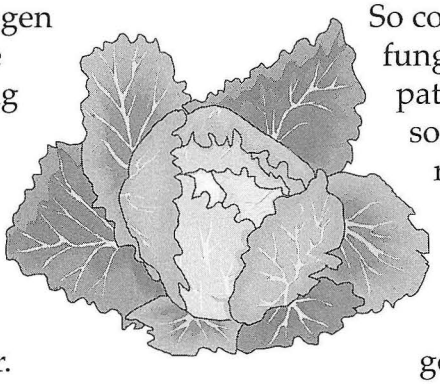
There is a great quote from more than a century ago from the Russian plant pathologist Antonin Woronin, who declared: "The only cure for cabbage hernia is fire!"

Until recently cabbage was generally not considered an ornamental plant, but Woronin's point still applies to us in the green industry. He was talking about a disease now known as club root of cabbage, caused by a primitive organism known as *Plasmodiophora brassicae.*

What he meant was that they had no cabbages with good genetic resistance to "cabbage hernia," no pesticides to control

it, and no way to seriously modify the environment conducive to disease.

But they could control it by sanitation — by getting rid of the pathogen — in this case by burning the infested fields after harvesting whatever they could each year. By burning the remaining herniated cabbage debris, they were reducing the amount of *P. brassicae* inoculum that overwintered to the next year.



We need to do the same thing with ornamental diseases, both during a disease outbreak and after that outbreak. Rose black spot is a good example.

Each spring when black spot-susceptible roses leaf out, they are exposed to infections by *Diplocarpon rosae.* Where does the fungus come from? From spores that survived the winter on old black spotted leaves and canes.

You cannot prevent spores from blowing in from other areas but you can greatly lessen the amount of fungal inoculum and the amount of black spot disease by cleaning up infested debris from the previous year.

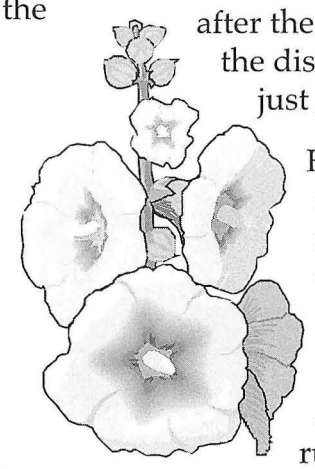
Not only that, but since this sanitation effort is never perfect, it is also important to clean up the black spotted leaves that develop during the current season's infections. Do not wait until the end of the year to clean up the planting.

Of course, the other way to preventively manage *D. rosae* is to spray labeled fungicides on foliage as it emerges and develops in order to kill the fungus as the microscopic spores are germinating and trying to enter wet leaf tissue. This effort, too, is of course always imperfect as timing and complete coverage are always challenging.

So combining sanitation and fungicides to control the pathogen, and use of at least some black-spot-resistant rose varieties mentioned earlier, and modifying the environment that we will discuss later — all combine to provide good integrated rose black spot control. All too often only one facet of the triangle — *e.g.*, use of fungicides — is employed, and control is inadequate.

Another example of sanitation to help control the pathogen is with hollyhock rust disease *(Puccinia malvacearum).* The orange turning to brick-red and chocolate-brown rust pustules are a common sight for almost everyone who has ever grown hollyhocks.

This fungus, like the rose black spot fungus has a repeating cycle that just goes on and on as the season progresses, so removing infested leaves during and after the season is one big key to getting the disease under control. Otherwise, it just gets worse and worse.



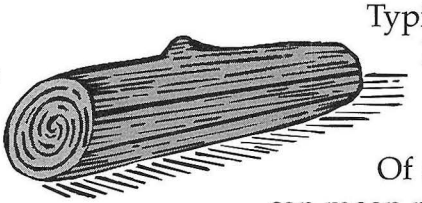
Fungicides help with hollyhock rust, but they must be applied multiple times and will not be enough without the help of removing pathogen inoculum when infestations do occur.

Another issue with hollyhock rust is a further aspect of sanitation — removal of additional hosts of *P. malvacearum.* It turns out that this fungus also infects a number of hollyhock's relatives in the Malvaceae

family, including weeds such as the round-leaved mallow, *Malva rotundifolia.*

Sometimes plant diseases become issues only after pathogens arrive in an area. Dutch elm disease *(Ophiostoma ulmi)* is a classic example. American elm *(Ulmus americana)* and other elms native to the United States are highly susceptible to infection by *O. ulmi.* The environment conducive to disease is present. The missing ingredient until the 1920s was that the pathogen was not present in the United States.

Then, in the late 1920s, elm logs were imported to the United States and transported across the country in open, flat-bed railway cars. These European elm logs were infested with European elm bark beetles which in turn carried *O. ulmi.* The beetles hopped off, fed on American elms, and vectored the pathogen to these highly susceptible elms.



The result was an epiphytotic that continues to this day. The disease triangle was completed by the introduction of the pathogen to the United States.

Continued control efforts range from looking for genetic resistance in elms; sanitation in communities where the disease has not already swept through, including removal of any infested wood where bark beetles can survive; and use of fungicides and insecticides for the bark beetle vectors.

Without question, sanitation is often not enough to prevent key diseases. Sometimes it is a matter of practical marshaling of resources. Though cleaning up a rose planting of black spotted rose tissue or a hollyhock planting of leaves and stems with rust may be possible, cleaning up all the scabby leaves from crabapples or an apple orchard is too time consuming.

Fungicides, in conjunction with the other facets of the triangle, are clearly one important approach. Proper selection of the right fungicide, applied with appropriate timing to prevent infection (we are not good at eradicating infections), and application in the right way to obtain good coverage and limit off-target application are all keys to proper fungicide use.

The Environment

The importance of an environment that is conducive to specific diseases cannot be overemphasized relative to the disease-triangle concept and infectious plant-disease control. Rose black spot is again a telling example.

Typically, wet seasons mean heavy rose black spot, and dry seasons mean light rose black spot problems. Of course, even a dry season can mean plenty of black spot if you irrigate regularly with overhead sprinklers. Therein lies a tale.

The tale is of greenhouse rose production. In the 1930s, rose black spot was a major problem in many rose greenhouse ranges. Today it is virtually non-existent. What changed? What facet of the disease triangle brought about this change?

Was it the host with new rose taxa with better genetic black-spot resistance? No. Was it better fungicides that preventively controlled *Diplocarpon rosae* during the infection process? No. The difference in incidence of rose black spot in greenhouse ranges between the 1930s and today is a change in the environment conducive to disease.

Here is what happened. One of the big problems in greenhouse rose production is spider-mite feeding. In the 1930s, the available miticides for spider mite control were inadequate. As a result, growers did the best they could; they washed off the spider mites with a coarse spray of water — many times a day. Presumably the spider mites could only take so much of this and in the end not as many of them made it back up to feed on rose leaves. The result was mite control — and serious rose black spot disease.

This was the case because *Diplocarpon rosae* needs water on the leaves in order to infect, the longer the better. During the 1940s and afterwards, effective miticides were developed, spider mite control resulted, and greenhouse rose growers no longer needed to wash the mites off the foliage regularly. In addition, over time growers have gone more and more to trickle irrigation.

Bottom line: virtually no water gets on the foliage of greenhouse-grown roses — and black spot has ceased to be a problem. Of course, production of these roses has migrated mostly to south of the border — but that is another story.

Unfortunately, if you grow roses outside, the equation shifts. You cannot control cosmic irrigation — rainfall — but you can still use the power of the triangle to limit the amount of time water is on the foliage.

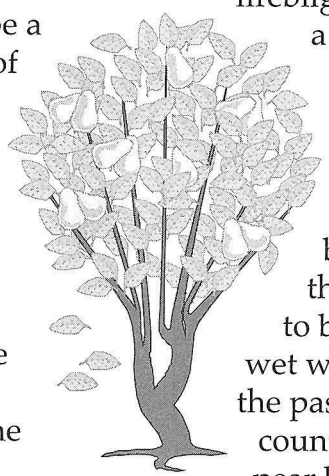
Plant roses in sunny sites rather than in shaded areas where there are poorer drying conditions and poorer air movement. Prune surrounding vegetation and do a good job of weeding — all to limit moistness in the planting. And, when possible, use surface rather than overhead irrigation.

If overhead irrigation is unavoidable, at least water early in the day, giving foliage a chance to dry before nightfall. Sometimes even this is not enough, for example, in very wet seasons, which is why you must employ all facets of the disease triangle.

Attack rose black spot in your plantings by using resistant varieties to the extent possible, by doing a good job of sanitation, by using preventive fungicides, and by managing the growing environment of your roses.

As noted earlier, the environment and the role it plays cannot be overestimated. For example, in Kentucky, Indiana, and Ohio, during the past three years we have learned some real lessons about bacterial fireblight disease *(Erwinia amylovora).*

Prior to these years we did not consider Callery pears as being seriously affected by this disease. When it did occur, the fireblight strikes often extended only a few inches on the shoots, rarely causing any significant dieback down the stem.



One of the keys to fireblight, though, is the extent of blossom infections, and one of the environmental factors leading to blossom infections is warm, wet weather during bloom. During the past three years in our area of the country, temperatures during Callery pear bloom have been unusually warm.

These temperatures in the 70s and even 80s (Fahrenheit) have correlated with very unusual and severe amounts of fireblight on Callery pears with many strikes per

plant and strikes extending much further down the stem than is typical. We now need to pay more attention to which Callery pears are more susceptible.

At Secrest Arboretum in Wooster and other areas of Ohio, for example, 'Aristocrat' and 'Autumn Blaze' seem to be especially affected, and we may even lose several 'Autumn Blaze' specimens, which is something we would have never imagined. Not until, that is, warm weather occurred during the Callery pear blooming period in mid-April for the past two years.

So, when you think of infectious plant diseases, remember the disease triangle and use it as a way to develop an integrated way to understanding and approaching disease control.

Infectious disease is not a simple thing with simple solutions, but a dynamic interaction between a susceptible host, a virulent pathogen, and an environment conducive to disease. Focusing on this, you can find many ways to try to break that triangle.

Sometimes one approach will do — a host with great resistance, outstanding sanitation in a greenhouse environment, keeping water off the foliage. More often it is the creative combination of approaches that involve all three facets of the triangle.

Expanding the Triangle

As noted previously, the idea of the plant-disease triangle as a way of understanding and controlling infectious plant diseases can be expanded with a few modifications. It can apply also to insects and mites.

For example, consider our native bronze birch borer insect, *Agrilus anxius.* We know that birches differ in their susceptibility, with European and Asian birch species such as *Betula pendula* and *Betula maximowicziana* more susceptible than our native birches such as *Betula populifolia* and especially *Betula nigra.*

We know that the insect pest *A. anxius* can be at least partially controlled with insecticide applications. And we know that environment plays a role in the problem, with birches growing in hot summer soils being more affected than those with less root stress due to mulched, shaded, cooler soils.

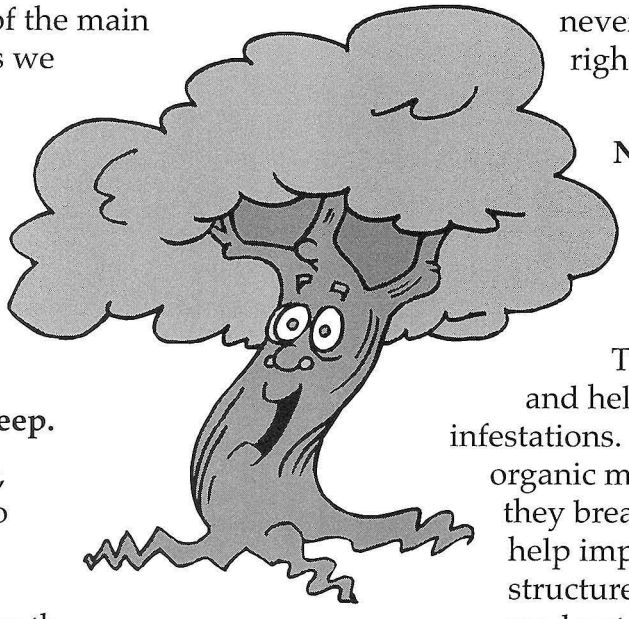
Bronze birch borer is a bigger problem in Kentucky and southern and central Ohio than it is in the upper peninsula of Michigan or the New Hampshire woods. So, this *plant pest triangle* involves the susceptible host, the pest, and the environment conducive to pest infestation.

Fittingly, there is a third three-sided triangle, to consider — one that we call the *horticultural problem triangle.* What are the three components of this triangle? What are the needed factors for horticultural problems to develop?

Well, the host plant and the environment it is in are crucial, as with the other triangles. The third and final ingredient is — PEOPLE! Yes, as the cartoon character Pogo used to say: "We have met the enemy and he is us!"

We, the people, are often intimately involved in why plants decline. We are analogous, so to speak, to the pathogen and the pest in the other triangles.

So, let's look at some of the main horticultural problems we perpetrate on plants. Let's call them the...



Seven Deadly Sins of Horticulture

No. 1: Planting Too Deep.

Plant roots need water, of course, but they also need oxygen. The fact is, concentrations of oxygen decline with depth of soil. This becomes critical when transplanting, even with the difference of a few inches, because transplanting already has resulted in significant stress to or loss of the root system.

So, when transplanting in a landscape, it is important to plant such that we are not burying the root flare too deep. We used to say that transplants should be planted at the same grade as the plant came from the nursery, but that is not quite right.

Sometimes, due to cultivation or the planting process in the nursery, the top of the ball is already significantly higher than the root system. So this must be adjusted to the extent possible at planting. Nevertheless, it is not uncommon to see trees and shrubs planted several inches to as much as a half foot or more too deep. Then everyone wonders why this tree declines in its first few months or years after transplanting. It is often simply too tough to overcome a bad start.

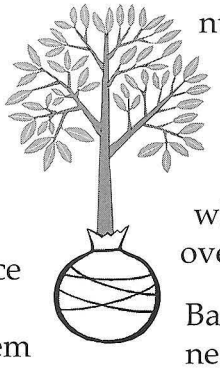
One final note: It is also a bad practice to plant too high, with the root ball sticking well out of the soil. "Plant 'em high, watch 'em die; plant 'em low, never grow; plant 'em right, sleep at night."

No. 2: Over-Mulching.

Organic mulches are a great asset in the landscape. They are attractive and help prevent weed infestations. They help provide organic matter for the soil as they break down and thus help improve long-term soil structure. Mulches also help moderate soil moisture and temperatures. Mulched areas help prevent lawn mower and weed whip injury of woody plants by keeping us away from the plants. Composted mulches even provide a microbial mix which can help moderate effects of certain plant pathogenic fungi.

Yet we tend to overdo too much of a good thing. Organic mulches should be at a depth of about 2-1/2 to 3 inches. Mounds of mulches up against trunks reaching depths of 4, 6, 8, 12 inches and more are common and simply keep too much moisture against trunk tissue and in the root zone, turning good horticulture bad.

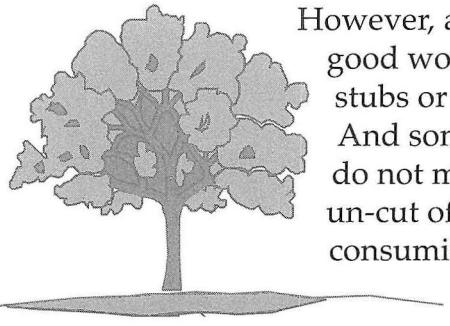
No. 3: Over-Fertilizing.



Fertilizers with NPK and with micro-nutrients as needed are important to plant growth and development. They are important components in the landscape and in nurseries and greenhouses. Yet they are also salts which can damage root tissue when over-applied.

Base application rates on soil tests and needs for optimal plant growth, rather than simply applying without

regard to proper calibration and recommendations. When soil tests indicate that phosphorous is already well beyond needed levels, do not keep pouring it on.



No. 4: Over-Watering.

Watering is not something that can be put onto a rigid schedule. How often do you see sprinklers running during a rainstorm?

As with deep planting, it is important to remember that plant roots need not just water, but also oxygen. When we overwater, roots do not properly respire and do not do their job of taking up minerals and water. Further, they become more susceptible to root-rotting fungal pathogens.

At the same time, certain root-rotting pathogens such as the water molds *Pythium* and *Phytophthora* thrive in low-oxygen, wet conditions, producing a double whammy for our root systems that are often finished off by these Dr. Treevorkians of the soil.

No. 5: Improper Pruning.

Pruning is another practice that is crucial when done correctly. Pruning out dead branches is an important safety practice. It is important from an aesthetic perspective, shaping a plant properly.

Pruning is also critical for the health of the plant, preventing crossing branches that damage each other when they grow together. Pruning is an important disease-control and pest-removal practice, as we improve air movement and the drying of leaves, as we remove diseased and infested tissue from black-knotted plums or oystershell scale-infested lilac stems.

However, all too often we prevent good wound closure by leaving stubs or making flush cuts. And sometimes the cut we do not make is the unkindest un-cut of all. Pruning is time-consuming and time is money, but it is better to pay as you go rather than to let pruning needs get out of hand and pay much more later.

No. 6: Pesticide Misapplications.

Pesticides such as insecticides, herbicides, and fungicides are obviously useful tools in plant health-care management. But we must avoid turning them into *iatrogenic agents*. Say what?

Iatrogenesis, according to the *American Heritage Dictionary* is "induced in a patient by a physician's activity, manner, or therapy." In medicine, then, an iatrogenic agent then might be something like a drug in which the side effects are worse than its intended beneficial effect.

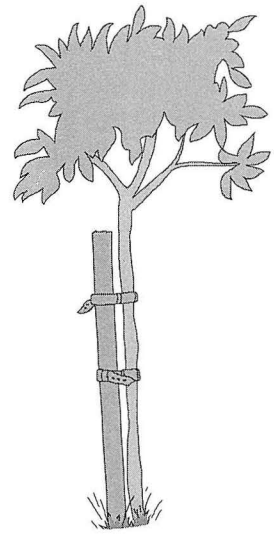
As plant doctors, our pesticides can become iatrogenic agents when an insecticide results in leaf scorch or an off-target herbicide causes leaf curling on desired plants in addition to killing unwanted weeds. For that matter, all of the good horticultural practices gone bad, from over-mulching to over-watering, are examples of iatrogenic agents. Just don't do it!

No. 7: Second-Degree Girdling.

This is our final example of when one of the seven deadly sins really turns into a crime. Loose non-degradable twine or wires at the planting of a tree become tight as time passes as the plant stem grows outward as new plant cells are

being produced by the vascular cambium in the stem.

This twine or wire becomes tight enough that it surrounds the stem, imbedded in the inner bark where the plant phloem is conducting food produced in the leaves down the stem to the roots. This girdling twine or wire thus girdles the stem, food backs up above the point of girdling, and the roots below the girdle die. The rest of the plant soon follows.



All because the natural conducting system of the plant no longer functions and the roots starve. All because of the action of us — the plant criminals. Yes, we may claim we did not mean to do it — that it was not pre-meditated murder. Fine, maybe it is second-degree murder — but the plant is dead nevertheless.

You might say that these things are all so obvious — yet they are also all so common. As we said earlier: It's not one darn thing after another — it's the same darn thing over and over and over again.

To break these triangles, to fully employ the power of the triangle, learn to think in three dimensions.

Note: This article is adapted from one by the same authors published in the May 1, 2003, issue of *American Nurseryman.*

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The USDA Agricultural Research Service Research Weather Station Network in Northern Ohio Nurseries

Ross D. Brazee, Keith A. Williams, David Lohnes, Richard C. Derksen, Heping Zhu, Randall H. Zondag, and Charles R. Krause

Brazee *et al.* (2002) reported on the status of efforts to develop a research weather network. The network is a part of cooperative research programs of the Application Technology Research Unit (ATRU) of the USDA/Agricultural Research Service, The Ohio State University, Ohio Agricultural Research and Development Center (OARDC) and nursery growers of Lake County, Ohio. This report will summarize some further developments of the network and provide information on accessing weather data.

The Weather Stations

The permanent weather stations at Sunleaf Nursery, Madison, Ohio, and at Klyn Nursery, Perry, Ohio, equipped with adapted UT-30 systems (Campbell Scientific, Inc., Logan, Utah), are intended to serve research programs and growers in the Lake County area. Data from these stations are available on a network web site. Individual growers may expect some variations in data from those that may exist at their own locations, particularly in growing degree-day information. These locations were selected as representative of commercial nursery locations, and of known or expected differences due to terrain and distance from Lake Erie. Local observations of selected data may be helpful in determining which station most nearly reflects a particular site.

A moveable station equipped with a Campbell Scientific CM-6 system is located in research plots at Madison. Data from this station is archived but not normally available at the web site. However, an experimental leaf wetness system is located with this station in a tree canopy. Some of this data is available at another web site on a seasonal basis.

Another permanent weather station is planned as part of a research program being developed at Willoway Nursery, Avon, Ohio. Meantime, this station is equipped with a CM-6 moveable system, with data currently available on the network web site.

Additional equipment has been installed and work is underway to connect the

Ross D. Brazee, Richard C. Derksen, Charles R. Krause, Keith A. Williams, and Heping Zhu, of the Application Technology Research Unit, USDA/Agricultural Research Service, Wooster, Ohio; David Lohnes, Communications and Technology, Ohio Agricultural Research and Development Center, The Ohio State University, Wooster, Ohio; and Randall H. Zondag, Ohio State University Extension, Painesville, Ohio.

Madison UT-30 station to the Soil Climate Analysis Network (SCAN) in cooperation with the USDA/Natural Resources Conservation Service (NRCS). This installation will enable inclusion of the Madison station on a national network, as well as providing supplemental soil moisture and temperature information.

Instrumentation

Brazee *et al.* (2002) list the main climatic variables for which data are archived or transmitted into the network, namely, wind speed and azimuth (direction), air temperature, relative humidity, and solar radiation. Rain or snow data are reported as equivalent liquid precipitation.

In the year 2003, soil temperature measurement capability was added to instrumentation at the Madison station. Soil temperature is measured at 2-, 4-, and 8-inch depths, and this data is accessible on the network web site. Later, NRCS personnel installed soil-temperature and moisture-sensing units near the existing sensors, but at depths of 2, 4, 8, 20, and 40 inches. Since special processing is required, these data are not currently available on the existing web site and will eventually appear on the SCAN Network.

Campbell Scientific leaf wetness sensors have been deployed experimentally at the CM-6 site at Madison since early 2002 and provide data on surface moisture resulting from either dew or rainfall. They sense moisture by means of electrical resistance and must be specially coated with white latex paint and aged for a period of time by the user before being deployed.

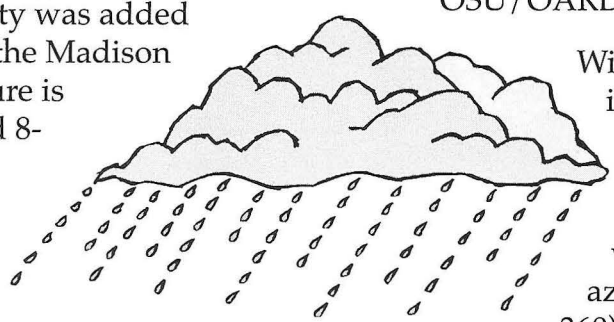
NRCS personnel have installed an auxiliary 20-ft. tower supporting a meteor-burst telemetry system to enable data transmission to the SCAN Network. Additionally, they have installed soil moisture and temperature sensing units at 2-, 4-, 8-, 20- and 40-inch depths.

Data Access

Data from the Avon CM-6 station and the Madison and Perry UT-30 stations are accessible at:

www.oardc.ohio-state.edu/usdaweather/

Either the Avon, Madison, or Perry station can be selected from among the links at the web site. The remaining links at the web site are for other locations in the OSU/OARDC Ohio network.



Wind speeds are shown in bar graph form, with wind direction given as arrows appearing at the tips of the wind-speed bars in azimuth degrees (zero to 360) clockwise from zero (north). Note that the wind azimuth arrows indicate the direction from which the wind is coming.

Occasionally, in freezing-rain conditions, the cup anemometer and even the wind vane may lock up due to icing. This gives the appearance of zero wind velocity, while the wind azimuth is indicated as north. This is a default azimuth indication, since anytime wind speed falls to zero, its azimuth becomes meaningless.

On the same page, air temperature and relative humidity are presented as red and blue "step" plots, respectively. Units of measurement are indicated for all plots, and numerical values can be read

by placing the display cursor on the plot location as desired. Data are presented at 15-minute intervals as available and are 15-minute averages for the variable of interest, with time indicated in 24-hour format.

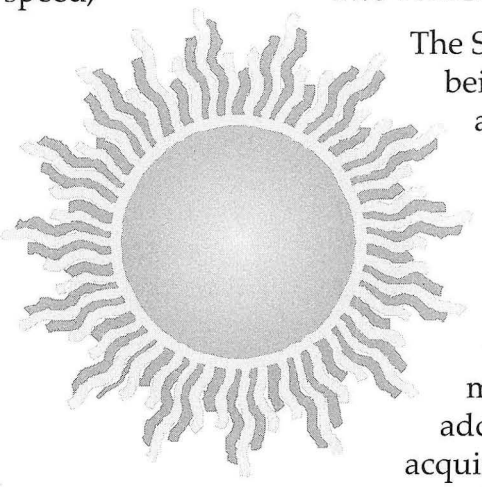
The ***Table Format*** link at the top of the page gives access to data in tabular form. In the table, wind speed, and standard deviation of wind speed, are expressed in miles per hour; azimuth is listed in degrees; and relative humidity is stated in percent. All other data are given in metric units, *i.e.*, temperature in Centigrade (Celsius) degrees and solar radiation in watts per square meter.

In the table near the bottom of the page, year-to-date totals for precipitation and for growing (GDD), cooling (CDD), and heating (HDD) degree-days are given. GDD are calculated by the modified sine wave method. The ***Modified Sine Wave Calculation*** link accesses details on tabulated and calculated data and a further link describing the modified sine wave calculation.

The link ***Phenology Calendar*** accesses the web site, *Growing Degree Days and Phenology for Ohio* that lists phenology data on blooming, hatching, or emergence for a wide selection of plants and pests, as compiled by Dr. Dan Herms. The link ***Detailed Summary*** accesses daily data for precipitation (rain or snow on a liquid basis), GDD, and average air temperature beginning January 1 of the year as chosen by the user.

The link at the bottom of the page allows the user to access available data for a selected date. Data for the complete day are presented in the usual form, except that an additional summary table is included, with included numbers identified in table headings. Additional data on soil temperatures at 2-, 4- and 8-inch depths are tabulated for the Madison station only.

The NRCS SCAN Network



The SCAN accessing system being installed as an adjunct to the Madison station is not available online as of this report. When activated, the system will provide soil moisture and temperature data as mentioned earlier, in addition to all other data acquired at the site. However, interested readers can access the SCAN network at:

http://www.wcc.nrcs.usda.gov/scan/

There are SCAN sites in more than 30 states and Puerto Rico.

Leaf Wetness Charts

The OSU Extension, Lake County office, has established a web site for leaf wetness charts based on data from the Madison CM-6 site at:

http://lake.osu.edu/hort/pg1.htm

Links are listed at this page for individual archived charts as available for the period May 3 through September 7, 2003. Each chart contains overlaid, color-coded plots for the full day of wetness data from two sensors, rainfall, temperature, and relative humidity, with a legend identifying each plot. Rainfall data appear as pulses, each

pulse indicating 0.01 inches of rainfall. Commentary appears on each chart to aid the user with interpretation.

Network Information

For more information, users may contact any of the authors.

Reference

Brazee, R. D., R. C. Derksen, C. R. Krause, K. A. Williams, D. Lohnes, M. G. Klein, M. Reding, R. Lyons, W. Hendricks, R. Zondag, R. D. Fox, and D. Herms. January 2003. The USDA / Agricultural Research Service Research Weather Network in Lake County, Ohio — 2002 Update. *Ornamental Plants, Annual Reports and Research Reviews, 2002.* The Ohio State University / Ohio Agricultural Research and Development Center, Special Circular 189: pp. 145-148.

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And all those at these or other nurseries who have helped in any way.

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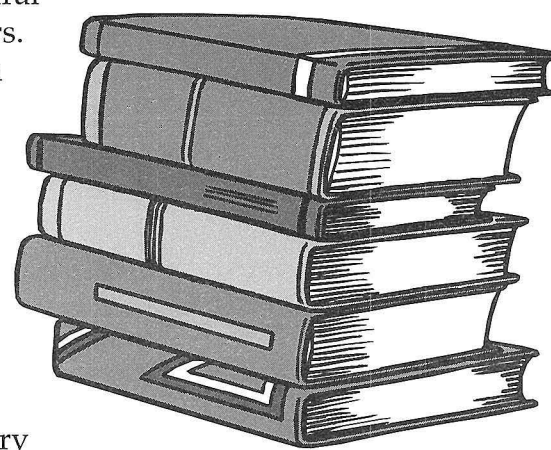
Useful Horticultural References for Green Industry Professionals

Gary Y. Gao and Pamela J. Bennett

This is the second installment of useful horticultural references for green industry professionals, horticultural educators, and gardeners. This list is a compilation of references that Extension agents use on a regular basis.

As one can imagine, such a list is a work in progress. Please note that prices listed in this article are approximate and can vary greatly.

Numerous Ohio State University Extension bulletins also are used on a daily basis. Many of these bulletins have been featured in the weekly *Buckeye Yard and Garden Line* over the years.



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Gary Y. Gao, Ohio State University Extension, Clermont County, and Pamela J. Bennett, Ohio State University Extension, Clark County

General References					
Author(s)	**Title**	**Publisher/ Year**	**ISBN**	**Approx. Price**	**Comments**
Roger Philips	*Trees of North America and Europe*	Random House	ISBN 0394-50259-0	$27.50	A photographic guide to more than 500 trees.
Debra Knapke and Alison Beck	*Annuals for Ohio*	Lone Pine	ISBN 1-55105-388-8	$18.95	A handy reference on annuals.
Debra Knapke and Alison Beck	*Perennials for Ohio*	Lone Pine	ISBN 1-55105-386-1	$18.95	A handy reference on perennials.
Janet Meakin Poor, Editor	*Plants That Merit Attention, Volume I: Trees*	Timber Press	ISBN: 0-917304-75-6	$59.95	A comprehensive reference on trees.
Kim Tripp and J. C. Raulston	*The Year in Trees*	Timber Press	ISBN: 0-88192-320-6	$44.95	A photographic journey covering superb woody plants for four-season gardens.
James Adams	*Landscaping with Herbs*	Timber Press	ISBN: 0-88192-073-8	$32.95	An excellent book on the design and maintenance of herb gardens.
Plant Maintenance					
Carl E. Whicomb	*Establish-ment and Maintenance of Landscape Plants*	Lacebark Inc. 1991	ISBN: 0-9613109-4-4	Varies	A good reference on plant maintenance.
Tracy Disabato-Aust	*The Well-Tended Mixed Garden*	Timber Press 2003	ISBN: 0-88192-559-4	$39.95	A great book on designing mixed borders.
Christopher Brickell and David Joyce	*The American Horticultural Society, Pruning and Training*	DK Publish-ing 1996	ISBN: 1-56458-331-7	$35.00	Excellent illustrations and photos on pruning.

Landscape Design					
Norman K. Booth and James E. Hiss	*Residential Landscape Architecture*	Prentice Hall	ISBN: 0-13-632019-8	$100.00	An excellent textbook on the design process for the private residence.
Grant W. Reid	*Landscape Graphics*	Whitney Library of Design	ISBN: 0-8230-7332-7	$24.95	A great reference on landscape graphics.
Jane Stoneham and Peter Thoday	*Landscape Design for Elderly and Disabled People*	Garden Art Press	ISBN: 1-870673-20-4	$24.95	A good resource if working with an older population.
Management					
Kerry Patterson, Joseph Grenny, Ron McMillan, and Al Switzler	*Crucial Conversations*	McGraw-Hill 2002	ISBN: 0-07-140194-6	$14.95	An excellent book on how to succeed in conversation as well as how to successfully listen.
Claudio Pasian	*Spanish for Greenhouse Supervisors*	Ohio State University Extension	Bulletin 900 or HORT1	$7.50	A handy reference for employers with Spanish-speaking employees.
Tony Avent	*So You Want to Start a Nursery*	Timber Press	ISBN: 0-88192-584-5	$24.95	A focus on the business and planning to make a successful business. Written in a fun and practical way.
Robert Spector and Patrick D. McCarthy	*The Nordstrom Way*	John Wiley & Sons, Inc.	ISBN: 0-471-16160-8	$15.95	A great book on customer service issues. Provides great ideas for our industry to copy.
Alan Axelrod and Jim Holtje	*201 Ways to Deal With Difficult People*	McGraw-Hill	ISBN: 0-07-006218-8	$10.95	A very easy-to-read self-help book that provides short snippets of ideas that are useful.

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The Ohio State University Chadwick Arboretum Learning Gardens in 2003

Steven M. Still and Annette K. Duetz

The renovated and expanded Gazebo Border in front of Kottman Hall is shown here. Howlett Hall is in the background. The bare strip betweeen the sidewalk and the plantings now boasts a healthy green turf and provides protection to the plants from salt used during the winter.

Under the leadership of Dr. Steven Still, the Chadwick Arboretum Learning Gardens team in the Department of Horticulture and Crop Science was able to install our initial garden in 2002.

The van Fossen Wildflower Garden had its first fabulous season this past spring. Our second project was the renovation of the small bed west of the Howlett Hall entrance. This area now hosts a shade garden.

Steven M. Still and Annette K. Duetz, The Ohio State University, Department of Horticulture and Crop Science.

In 2003 we then renovated and expanded the Gazebo Border in front of Kottman Hall. Nance McAleer, a former Mayhew scholar and undergraduate student, did the design for this area.

Our largest project in 2003, however, was the installation of the Kleinmaier Perennial Garden. This garden, an area of approximately 6,000 square feet, focuses on perennials, shrubs, and small trees.

Deb Knapke, a former undergraduate and graduate student in the department, designed this garden, which is also located in front of Kottman and Howlett Hall. Only a few finishing touches remain for next spring and the garden will be complete.

Ever since we began developing the Learning Gardens in front of the Horticulture and Crop Science buildings, we have been able to generate a lot of interest from the industry as well as from the public. This is largely due to the colorful trial gardens that are maintained year-round under the leadership of Dr. Claudio Pasian and Monica Kmetz-Gonzalez.

This fall new beds are emerging at the corner of Woody Hayes Drive and Fyffe Court. After resting over the winter, these beds will host their first crop in the spring of 2004.

Some future projects in the Learning Gardens are the relocation of the Minton Rose Garden from main campus, the renovation of the entrance beds in front of Howlett Hall, and a possible extension of the van Fossen Wildflower Garden.

Horticulture students will begin the design process in class, and Chadwick's own Mayhew scholars will then take over with the installation and maintenance of the areas.

The interest and support of the industry has been very encouraging throughout our first two years. Kurtz Brothers and the city of Columbus Compost Facility have given us large amounts of both amendment and mulch.

Our summer and winter annual display was only possible due to the generosity of Possum Run Nursery and deMonye's Greenhouses. Green Velvet Sod Farms donated the new turf in the Kleinmaier Garden and the Gazebo Border.

The Learning Gardens have not only become an everyday destination for faculty, staff, students, and volunteers, but they have also become a welcome rest area for visitors passing through on their way to main campus. All of this makes our Learning Gardens a very unique place where you can experience and learn about horticulture first-hand.

Come and see for yourself!

Notes

Notes

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Director

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